Vol. X. No. CCXXVI. | [illegible] MARCH 25, 1882. | [illegible] | Price Fourpence.

THE ELECTRICAL REVIEW

LONDON: HAUGHTON & COMPANY, 10, PATERNOSTER ROW, E.C.
New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: M. Breguet, 39, Quai de l'Horloge; Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque. Berlin: A. Asher & Co., 5, Unter den Linden.

JOHNSON & PHILLIPS,
TELEGRAPH ENGINEERS, ELECTRICIANS, AND CONTRACTORS.
OFFICE: 16, UNION COURT, OLD BROAD STREET, LONDON, E.C.
WORKS: VICTORIA ROAD, CHARLTON, LONDON, S.E.

Manufacturers of all Telegraph Appliances, Materials, and Machinery for Making and Laying Submarine Cables, and Contractors for Underground & Aerial Telegraphs.

Iron and Steel Telegraph Buoys, Grapnels, both Patent and Ordinary; Centipedes, Creepers, Mushrooms, Sinkers, Cable Tanks, Picking-up and Paying-out Machinery, Dynamometers, Bow and Stern Gear, Steam and Hand Hauling Gears, Rope and Chain Fittings, Cable Drums, Splicing and Jointing Tools, &c., &c.

Machinery Designed and Constructed for the Complete Equipment of Telegraph Cable Factories and Vessels. Wire Testing Machines for Tension, Elongation, and Torsion. Special Wire Sounding Machines for Shallow and Deep Water.

All Apparatus and Material used in the Construction and Maintenance of **LAND LINES**, viz.:—

INSULATORS—*Johnson & Phillips'* Patent Fluid Insulators, and all kinds of the ordinary form, Shackles, Shackle Straps, &c.

BATTERIES—Sole Makers of *Higgins'* Patent Bichromatic Batteries, and all the ordinary forms. Contractors for the supply of Zinc and Carbon Battery Plates of special quality.

POLES—Wrought Iron or Composite Poles of various kinds, for Telegraph, Telephone, and Electric Light purposes.

Makers of Special Underground Torpedo and Field Cables, with Single or Multiple Cores.

Insulated Copper Wires, Strand and Ropes, taped or braided, cotton or silk covered.

ELECTRIC LIGHT—Makers of Brockie's Electric Lamp.
Every description of Leading WIRES and CABLES. CARBON RODS, both Black and Coppered.

SOLE MAKERS OF VYLE'S PATENT EASILY TESTED LIGHTNING CONDUCTORS.

HOOPER'S TELEGRAPH & INDIA RUBBER WORKS,
Offices:—31, LOMBARD STREET, LONDON, E.C. Works:—MITCHAM and MILLWALL DOCKS.

MANUFACTURERS OF SUBMARINE AND SUBTERRANEAN TELEGRAPH CABLES
UNDER HOOPER'S PATENTS.

MEDAL OF PROGRESS, 1873.

CONTRACTORS TO
[illegible]
[illegible]
AND TO THE CONTINENTAL GOVERNMENTS.

ROWATT & FYFE'S ELECTRIC LIGHT COMPANY, LIMITED,

AND

ELECTRIC LIGHT AGENCY.

PILSEN ARC LIGHT. JOEL'S INCANDESCENT LIGHT.

Manufacturers and Contractors for all Descriptions of Electric Light.

JAMES H. McKEAN, *Secretary.* | HENRY F. JOEL, A.M.I.C.E., *Engineer.*

52, QUEEN VICTORIA STREET, LONDON, E.C.

Contractors to H.M. Postmaster-General, the Indian Government, the principal Railway, Telephone, and Electric Light Companies.

INDEX TO THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW ADVERTISEMENTS.

No charge is made for inserting the Names of firms whose advertisements are ordered for a series of insertions in this Journal during the continuance of such advertisements.

(The numbers refer to the page on which the displayed advertisement will be found.)

	PAGE
Cabinet Work.	
G. Beech	2
W. M. Foxcroft	3
G. Wilson & Son	4
Clock-Work Manufacturers.	
Oppermann Brothers	4
Clock Synchronising.	
Barraud & Lunds...	4
Electrical Engineers and Contractors.	
W. T. Henley	3
Hooper & Co.	1
India-rubber and Telegraph Works Co.	12
Johnson & Phillips	1
E. Paterson	11
L. G. Tillotson & Co.	6
Electric Light.	
Compagnie Générale	3
Griffith & Co.	4
Rowatt & Fyfe's Company	2
Insulators.	
Bourne & Co.	7
David Brooks	5
Stiff & Sons	8
Liebig's Extract of Meat and Malt Wine.	
Coleman & Co.	8
Lightning Conductors.	
Newall & Co.	9
Machinery.	
Thos. Barraclough & Co. (Limited ...	4
Manufacturing Electricians.	
T. Crampton & Co.	3
Gent & Co.	4
Patent Agents.	
Howson & Son (U.S.A.)	5
Robertson, Brooman & Co. (Eng.) ...	5
Periodicals.	
"European Mail"	5
"L'Electricien"	6
"Railway Supplies Journal"	8
Photographic.	
Wratten & Wainwright	2
Screws.	
Davis & Timmins...	10
International Machine Company ...	4
Telephones.	
Blakey, Emmott & Co.	8
Harrison, Cox-Walker & Co.	9
J. Orme & Co.	10
Swiss Telephone Company	7
M. Theiler & Sons	6
Wire (covered).	
W. T. Glover & Co.	2
London Electric Wire Company ...	9
Phillips Brothers...	11
Wire (uncovered).	
R. Johnson & Nephew	2
F. Smith & Co.	3
Webster and Horsfall	9

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

Vol. X. MARCH 25, 1882. No. CCXXVI.

CONTENTS:

	PAGE
Secondary Batteries or Accumulators	209
Sabine's Apparatus for showing the Electromotive Action of Light upon Selenium immersed in Water	210
Sabine's Apparatus for Ascertaining the Contour and Speed of Electric Waves passing through Telegraph Lines (*illustrated*)	210
On the Chemistry of the Planté and Faure Accumulators	211
Electric Lighting for Streets	213
On Photometers. I.	214
Review	215
Correspondence:—	
Technical Education	215
Arc *v.* Incandescence	216
The Action of the Telephone	216
The Electrical Resistance of Carbon under Pressure	218
Notes (*illustrated*)	218
New Patents	222
Abstracts of Published Specifications (*illustrated*)	222
City Notes	224
Quotations	224

PATENTS FOR INVENTIONS.

ROBERTSON, BROOMAN & CO. (established 50 years), continue to obtain Patents for Inventions. Pamphlet, containing special advice, gratis or by post. 166, Fleet Street, London.

WILLIAM M. FOXCROFT,
Telegraph Instrument Case Manufacturer,
54, COMPTON ST., CLERKENWELL.
INSTRUMENT CASES OF ALL DESCRIPTIONS,
Wholesale Maker of the Gower-Bell Telephone Case as adopted by Her Majesty's Government.
Lock and Block, Single Needle, Bell, Sounder, and Perforator.
PRIZE MEDAL, PARIS, 1881.
CABINET WORK DESIGNED TO SUIT NEW INSTRUMENTS.

ELECTRICAL & SCIENTIFIC APPARATUS.

Manufacturers of Electric Bells, Indicators, Constant Batteries, Telephone Switches and Transmitters, Induction Coils, Terminals, Carbons, Wires, &c.

Complete Catalogue, Two Stamps.

THOMAS CRAMPTON & CO.,
MANUFACTURING ELECTRICIANS AND OPTICIANS,
251, High Holborn, London, W.C.

RICHARD JOHNSON & NEPHEW,
MANCHESTER.
TELEGRAPH AND TELEPHONE LINE WIRE.
London Office:
8, GREAT WINCHESTER STREET, E.C.

GEORGE BEECH,
Telegraph Instrument Case Manufacturer by Steam Power,
109, DALSTON LANE,
KINGSLAND.
Railway and Telegraph Engineers supplied with every description of Telegraph Instrument Cases, Single Needle, Block, Bell, Switch, &c. The material and workmanship of first quality and guaranteed. (Established 1872.)
Drawings for New Designs got out for approval.

THE
"JAMIN" PATENT ELECTRIC LIGHT.
Compagnie Générale d'Eclairage Electrique.
CAPITAL 8,000,000 FRANCS.
Proprietors of the Gramme Patent Machine for Alternate Currents.
J. A. BERLY, C.E., A.S.T.E., &c., Engineer,
And Sole Agent for Great Britain and the Colonies,
16, NEW BRIDGE STREET, LONDON.

FREDERICK SMITH & Co.,
Contractors to H.M. Postmaster-General,
CALEDONIA WORKS, HALIFAX, ENGLAND.

SPECIALITIES:
PATENT GALVANISED

Galvanised Strand Wire.
Stay Wire (special).
3/16 *Strand High Conductivity.*
Patent Galvanised Binding Wire.
Line Wire to all Specifications.

Cable Wire.
Patent Steel Wire for Hawsers and Deep-Sea Sounding Lines.
Galvanised Patent Steel Wire for Long Spans.

WITHOUT JOINT OR WELD.

Prize Medals:—London, 1862; *Paris,* 1867; *Moscow,* 1872; *Vienna,* 1873; *Paris,* 1878; *Philadelphia,* 1876.

TELEGRAPH CABLE MAKING MACHINERY
Suitable for every description of Cables (Land and Submarine).

WIRE STRANDING MACHINES
For making Telegraph Strand with any number of wires from 3 to 19.
CORE SERVING MACHINES of all sizes.
TAPING MACHINES, Single and Double.
WIRE COVERING MACHINES of every description for covering wire with india-rubber, gutta-percha, hemp, flax, cotton, silk, &c.
COMPLETE SETS of Machine for purifying and preparing INDIA-RUBBER and GUTTA-PERCHA for Telegraphic purposes.
Estimates furnished on application. For Plans of Works a fee is charged proportionate to the labour involved.

THOMAS BARRACLOUGH & Co., Limited, 8, King Street, Manchester.

GRIFFITH & Co.,
(Late Harborow & Co.),
ELECTRIC LIGHT ENGINEERS,
AND
TELEGRAPH INSTRUMENT MANUFACTURERS,
4, CIRCUS ST., LONDON, W.

THE INTERNATIONAL MACHINE COMPANY,
MANUFACTURERS OF ALL KINDS OF
SCREWS IN IRON, STEEL, OR BRASS.
Telegraph and Telephone Work.
BINDERS, TERMINALS, CLAMPS, &C.
Turned or shaped parts for Dynamo and Magneto Machines.
OFFICE—118, WHITEHORSE ST., COMMERCIAL RD., LONDON, E.C.

BARRAUD & LUNDS,
41, CORNHILL, E.C.
(ESTABLISHED OVER A CENTURY),
MANUFACTURERS, PATENTEES AND IMPORTERS OF
Chronometers, Half-Chronometers, Lever Watches, &c. Turret, Hall, and Electric Clocks
Inventors and Patentees of the New Method of
SYNCHRONISING CLOCKS,
Which keeps invariably set to Mean Time all Clocks electrically connected.

THE FOLLOWING TELEGRAPH AND RAILWAY COMPANIES HAVE ADOPTED THE SYSTEM:—
EASTERN TELEGRAPH COMPANY.
ANGLO-AMERICAN TELEGRAPH COMPANY.
INDO-EUROPEAN TELEGRAPH COMPANY.
PARIS AND NEW YORK TELEGRAPH COMPANY.
GREAT NORTHERN TELEGRAPH COMPANY.
AMERICAN CABLE COMPANY.
GREAT EASTERN RAILWAY.
METROPOLITAN RAILWAY.
MIDLAND RAILWAY.
LONDON AND NORTH-WESTERN RAILWAY

M. SADLER,
INVENTOR OF THE
UPRIGHT MAGNETIC MACHINE,
So universally used by the Medical Profession,
MANUFACTURER OF
Electrical, Galvanic, Magnetic, Chemical, Photographic and Pneumonic Apparatus.
Electric Bells and Indicators of every description.
For Hotels, Warehouses, Manufactories, Mines, and Domestic and General use.
19, ASTON STREET, BIRMINGHAM.

OPPERMANN BROTHERS,
MANUFACTURERS OF TELEGRAPH, ELECTRICAL, AND OTHER MACHINES.
Wheel Pinion, Rack and Endless Screw Cutters for Watch, Clock, and Telegraph work. Experimental and small Mechanical work of every Description for Inventors and Scientific gentlemen. That connected with Electric Lighting a Speciality.
41, SPENCER STREET, LONDON, E.C.

G. WILSON & SON,
Telegraph Instrument Case Manufacturers by Steam Power,
PHŒNIX WORKS, HARTLEY ST.,
HALIFAX (YORKSHIRE).
ESTABLISHED 1875.

THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. X.—NO. 226.

SECONDARY BATTERIES OR ACCUMULATORS.

M. **HOSPITALIER**, in an article on the storage of electricity very truly remarks that "the progress in electrical science proceeds by successive impulses, by a sort of concentration of the studies of the majority of investigators into a determinate channel." Dynamo machines, arc electric lamps, electric lighting by incandescence, are all subjects which for a time kept possession of inventors' minds, and now all electricians are bent upon solving the important question of electric accumulators. Opinions are pretty fairly divided on the ultimate success or failure of this new branch of electrical science, for while one set of experimenters give forth to the world the results of their work, and speak in the most enthusiastic manner as to the practical value of these so-called accumulators of electricity; others, whose opinions are equally worthy of consideration, feel compelled to cast doubts upon the subject, if not to intimate that it is questionable whether these secondary batteries will ever be more than supplementary appliances, in a limited way, to the apparatus we already possess for the purposes of electric-lighting or the transmission of power.

It is not our intention to enter into the past history of these well-known batteries, but we do consider that M. Gaston Planté, who for over twenty years has worked at this subject, and so cleared the way for present inventors, deserves more honourable mention than has yet been accorded him. He not only found the best metals to work with, but clearly explained the condition of each electrode after a charging current had been passed through the cell. It is to be regretted that M. Planté did not hit upon the idea of coating his sheets of lead with minium by hand, and so reduce the time of charging for producing the essential conditions of the plates necessary to the successful production of the secondary current. It has, however, been reserved for M. Camille Faure to put this finishing touch upon the work of Planté, and to produce a secondary battery which is the only one in commercial use, and which would, perhaps, have never attained its present notoriety had it not been for the circumstances under which it was brought forward, and the position of those by whom it has been nurtured. It may be worthy of remark, however, that it appears extremely doubtful whether M. Faure was the first to construct secondary batteries (in one important point) as claimed by him. In a recent lecture* it was stated that the following information was published in an English periodical as far back as 1863.

"The great power of the secondary combinations we have referred to is due to the presence of the peroxide of lead in contact with the negative element in these combinations. This substance, as was pointed out by M. De la Rive, surpasses even nitric acid in its affinity for hydrogen, and for this reason a couple constructed with a negative element of platinum, *surrounded by a mixture of dilute sulphuric acid and the peroxide of lead*,* and with a positive element of amalgamated zinc, in dilute sulphuric acid, is more powerful even than the couple of Grove. And when lead, instead of platinum, is used for the negative element, the power of the couple is but little diminished."

As the lecturers remarked, the above mixture was evidently put on by hand, and for the purpose of cheapness and simplicity, for the writer of the article speaks of the great cost of the peroxide when obtained electrolytically. It will be observed that in one instance the two metals employed were platinum and zinc, whereas M. Faure employs lead for *both* electrodes. We print this extract, however, for the guidance and information of those numerous electricians who are still endeavouring to produce secondary batteries, and not as a diatribe against the invention of M. Faure, who as a painstaking and diligent investigator of known phenomena has no superior. In our last issue we published a translation from our contemporary, *La Lumière Electrique*, on some experiments made with Faure's cells at the Conservatoire des Arts-et-Métiers. This is perhaps the most important paper which has yet appeared on this subject, and the opinions formed from these experiments by the authors are not of a very hopeful character. M. Planté's arrangement of cell has up to the present required a long time for charging, this drawback M. Faure's invention is intended to obviate; but it is found that to get the best effect from these cells, it is advisable to charge them with the weakest possible current, and consequently to prolong the duration of the charge. This result is confirmed by Drs. J. H. Gladstone and Alfred Tribe, in their paper on the "Chemistry of the Planté and Fauré Accumulators," published in *Nature* of March 16th. We have had recently sufficient information as to what may be expected from the Faure battery in the matter of work given out in comparison with work required for charging, but we are in ignorance as to the lasting capabilities of these cells. It was observed a few months since that the plates were frequently short-circuited by lead trees, or particles of metallic lead pricking through the felt with which the plates are covered, and thus making connection one with the other. We believe this has recently been denied by the Faure Company. The enormous weight of each cell is also a great disadvantage, the cost of course being proportionately high. A few weeks since it was rumoured that a new secondary battery had been devised of smaller dimensions and of less weight than that of Faure, and capable of producing about three times greater strength of current. This, we should imagine, if true, must be due to thinner plates being employed, and therefore a larger number in each cell, thus giving a less internal resistance than the Faure accumulator, but the consequence of this would probably be that the "unknown" cell would not be so lasting. There are certain advantages attached to secondary batteries if they can be produced commercially, but to do this successfully the price must be materially reduced. These batteries as they exist are like leaky reservoirs, for a secondary battery in giving out its energy loses a certain percentage of what was put into it; and as at present constructed it is difficult to see how the formation of lead trees, and therefore short circuiting, can be obviated, except by the employment of porous divisions which would increase the resistance of the cells so materially as to reduce their power beyond useful limits. In the special case of tramcars, where the advocates of secondary batteries propose to introduce them for propelling purposes, it would be interesting to know at what cost per annum each car is now worked by horses, including of course all other expenses. We do not see that the use of these cells on tramcars would lessen the number of drivers and conductors, for each car must have two men in either case, if only for sighting intending passengers before and behind. We think that the cost of propulsion, if the Leytonstone experiment is considered as an example of electrical driving, would be considerably in favour of horseflesh. What we really require to know now is the length of time required, and the cost of charging these cells by means of a dynamo machine driven by a steam-engine until they are in the best condition for work, and the length of time each cell may be said to last without repairs or renewal. We shall in a future number return to this subject, feeling at the moment that if the Faure or any other accumulator comes into extensive use it will be as a matter of convenience, and not one of necessity, for the various requirements of electrical science.

---

* "Notes on Electric Light Engineering," by C. H. W. Biggs and W. W. Beaumont.

* It is not, however, stated how this peroxide was obtained, the rapid formation of which is essentially the great feature in M. Faure's invention.—[ED. ELEC. REV.]

SABINE'S APPARATUS FOR SHOWING THE ELECTROMOTIVE ACTION OF LIGHT UPON SELENIUM IMMERSED IN WATER.

THIS exhibit* consisted of two parts—(1) a galvanic cell formed by two selenium surfaces, one of which is exposed to light when the cell is to be put in action; and (2) an apparatus for demonstrating that the current due to the action of light upon the selenium plate in the above cell is in the same direction as that produced by heat upon the same plate when kept in the dark.

The cell is constructed in two forms: in one of them two similar plates of selenium crystallised at 200° C., with platinum wires fused into them, are suspended side by side in a suitable vessel which is inclosed in a light-tight case provided with shutters. The vessel contains also a porous diaphragm which separates the suspended selenium plates, with a view to keeping one of them in the dark when the shutter opposite the other is lifted to admit light. Distilled water is poured into the vessel so as to reach about three-fourths up each plate. When both plates are in the dark, it is found that a very slight electromotive force exists between them, due to inequalities in the nature of the surfaces. When one of the shutters is lifted, and diffused daylight allowed to fall upon one of the plates, an electromotive force is found to exist, the plate upon which light falls being negative to the plate in the dark with a difference of potential of 0·5 to 1 volt, according to the intensity of the light which reaches the selenium surface.

The other form of cell is constructed with a single plate of crystalline selenium, which is rendered impervious to water by being saturated with solid paraffin. This plate is mounted in an ebonite ring, on each side of which is a thick ring of lead covered with a circular plate of glass in such a way that the space between the glass and selenium on each side may be filled with water, the connections being made to the lead rings. The cell so made up is contained in a wooden case provided with shutters to admit light either to the back or front side of the selenium. The electrical effect is of course the same as in the other form, the admission of light causing the exposed selenium surface to become electro-negative to the dark surface. The advantage of this form of cell is the reduction of resistance and the avoidance of wires fused into the selenium.

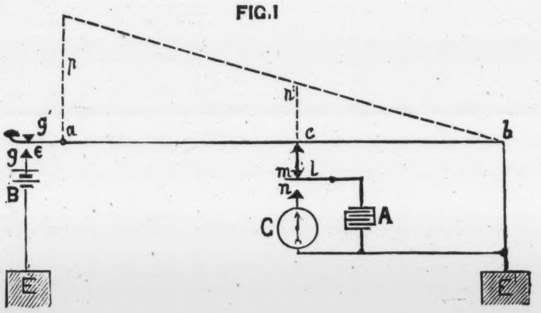
Another part of the arrangement is the apparatus for showing that the electrical effects caused by heat and light are identical. This apparatus consists of a plate of crystalline selenium which lies across the tops of two vessels containing distilled water, the water in the two vessels being connected also through platinum electrodes with a delicate galvanometer. The vessels are protected from the light by a suitable box; but by means of shutters light can be admitted to either of the ends of the selenium in contact with the water, or the whole can be kept dark, and the contact surface of the water and selenium at either end of the plate can be heated or cooled. With this apparatus it is shown that both heat and light render the selenium surface electro-negative.

SABINE'S APPARATUS FOR ASCERTAINING THE CONTOUR AND SPEED OF ELECTRIC WAVES PASSING THROUGH TELEGRAPH LINES.

THE propagation of an electric wave passing through a telegraph line is ascertained by this method, by which the potential of any given point in a line may be ascertained quantitatively at intervals of $\frac{1}{1000}$ of a second or less after starting the electric impulse, so that the exact contour of a wave, from the first instant of its gaining sufficient strength to move a delicate mirror-galvanometer, may be measured from point to point to its maximum, and, if required, to its gradual disappearance. By this method it becomes possible also to ascertain the speed of a wave, by observing the time which is taken for any given part of it to pass between two given points in the line.

This method is in principle as follows:—The conductor or line, *a b* (fig. 1), is furnished at one end, *a*, with a contact-key, *e*, which can be pressed upon the contact-stud, *g*, and puts in circuit the battery, B, one pole of which is attached to an earth-plate, E; at the other end, *b*, the conductor is put to a second earth-plate, E′. Some intermediate point, *c*, is put into connection with a contact-stud, *m*, against which the key, *l*, presses. To *l* is connected one side of an accumulator, A, the other side of which is put to earth, E′. A second contact-stud, *n*, connected through a galvanometer to the earth side of the accumulator, allows the latter to be discharged and the potential of its contents ascertained at any moment. The potential of the accumulator (whose capacity must be small in comparison with the capacity of the line), whilst in contact with the point, *c*, may be assumed to be identical with that of *c*; so that by depressing the key, *l*, the excursion of the galvanometer-needle indicates the electrical state which *c* had at the instant that *l* was separated from *m*. Now suppose an appreciable time to be required for any recognisable strength of wave to travel from *a* to *c*; if the key, *e*, be depressed and make contact with *g* at the

FIG. I



---

* Paris Electrical Exhibition, 1881, British Section.

instant l is separated from m, it is evident that (no alteration having taken place in the potential at c) no movement of the galvanometer will be observed. If, however, the key, e, be held down a long time before l is separated from m, electricity will flow through, and each point along the resistance, a b, will assume the potential due to its position, from p (at a) to zero (at b), as indicated by the diagonal. The discharge of the accumulator will then give an excursion of the needle proportional to the potential, p_1, of the point, c. After contact of the battery at a, every point in the conductor takes a certain time before it attains the maximum potential due to its position. By gradually increasing the time which elapses between the contact of e with g and the break between l and m, the potential which the point c from interval to interval attains being observed, the contour of the wave is found. The point, c, may of course be chosen in any position between a and b, to suit the galvanometer or otherwise.

By a slight modification, the time which the neutral point between two waves of opposite sign, takes to arrive at c may be determined, and at the same time the contour of the vanishing and increasing waves. For this purpose it is only necessary to furnish the key, e, at the end, a, of the conductor with a second contact-stud, g', in connection with a second battery which supplies opposite electricity to that supplied by B. The current of this second battery is either kept flowing through until the reverse wave from B is transmitted, or it may be inserted for a short interval only as when working a line with reverse currents.

The apparatus by which these contacts are given consists of a circular disc, which, when started into rotation, makes one revolution in 0·5 second. Its periphery is divided into 500 equal parts, so that the pointer can be adjusted by means of a nonius, which it carries to $\frac{1}{10000}$th of a second from the zero of the scale, which is of course made to correspond with the action upon the key, e. When the pointer or hand comes round it strikes the tongue, l, from m to n and discharges the accumulator, thereby showing the electrical condition of the point, c, of the line at the moment.

With this instrument on a length of 304 knots of coiled cable it was found that the wave travelled at the rate of 6,000 knots per second.*

ON THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS.†

PART II.—THE CHARGING OF THE CELL.

IN *Nature* (vol. xxv., p. 221) we directed attention principally to the local action that takes place on the negative plate of a Planté or Faure battery. We pointed out the close analogy between zinc coated with spongy copper and lead coated with spongy peroxide, in their action on water or dilute sulphuric acid; and we showed the importance of the lead sulphate produced in moderating this action. We now propose to treat of the chemical changes involved in the preparation of the cells.

The procedure of Planté in forming his battery is at first sight extremely simple. He takes two coils of lead, separated from one another, and immersed in dilute sulphuric acid: a current is sent through the liquid from one lead plate to the other, and the final result is that the one becomes covered with a coating of lead peroxide, while hydrogen is given off against the other plate. On the view that the sulphuric acid merely serves to diminish the resistance, and so facilitate the electrolysis of water, the ready explanation would be given that the two elements of the water are simply separated at the two poles. But it seems more in accordance with the facts of electrolysis to suppose that the sulphuric acid, H_2SO_4, is itself the electrolyte, and that the oxygen results from a secondary chemical reaction. As a matter of fact, if water be employed no peroxide is formed, but only the hydrated protoxide, even though a current from twenty-four Grove's cells be made use of. The addition of a single drop of sulphuric acid to the water is enough to cause the immediate production of the puce-coloured oxide.

If we take two plates of lead in dilute sulphuric acid, and pass the current from only one Grove's cell, a film of white sulphate, instead of peroxide, makes its appearance on the positive pole, and the action practically ceases very soon. If, however, the current be increased in strength, the sulphate disappears, and peroxide is found in its place. In Planté's procedure, spongy lead and lead peroxide are indeed found on the respective plates. But in consequence of the local action which takes place during the periods of repose, lead sulphate will be produced from the peroxide, and afterwards, in the course of the "formation," this must be reduced to metallic lead by the hydrogen.

It may seem at first sight improbable that an almost insoluble salt of the character of lead-sulphate should be decomposed under these circumstances. To test this fact by direct experiment, we covered two platinum plates with lead-sulphate, immersed them in dilute sulphuric acid, and sent a current through. We found not only that the sulphate was reduced by electrolytic hydrogen, but that it was peroxidised by electrolytic oxygen. The white sulphate was, in fact, decomposed to a large extent at each plate, the positive being covered with deep chocolate-coloured peroxide, the negative with grey spongy lead......The coating of peroxide interposes a great difficulty in the way of the further oxidation of the metallic lead. Hence Planté needs the successive periods of repose to admit by local action of the formation of lead-sulphate, and the oxidation of the increasing amounts of finely-divided lead thus brought into the field of action.

To obviate this waste of power and time, Faure covers both plates with red lead, and converts this into spongy peroxide and spongy lead respectively by the current. Now the first thing that happens when the plates are immersed in the dilute sulphuric acid is a purely chemical action. The minium suffers decomposition according to the formula—

$$Pb_3O_4 + 2H_2SO_4 = PbO_2 + 2PbSO_4 + 2H_2O.$$

But as both the lead sulphate and lead peroxide are insoluble, this takes place mainly at the surface, and requires time to penetrate. Thus in an experiment performed with the object of testing this point, the following amounts of minium were found to be converted into lead-sulphate in successive periods of time.

Time.	Minium changed into sulphate.
15 minutes	11·8 per cent.
30 ,,	13·7 ,,
60 ,,	14·6 ,,
120 ,,	18·1 ,,

It might happen, and we are told it has happened, that the amount of minium employed has been great enough to abstract the sulphuric acid from solution, leaving only water. In that case water, of course, would be the electrolyte, and there can be little doubt that the lead plate would suffer oxidation in the manner which was described by us some years ago (*Chem. Soc. Journ.*, 1876) in a paper on "Phenomena accompanying the Electrolysis of Water with Oxidisable Electrodes." This paper detailed the results obtained on passing a current from one Grove's cell between two plates of the same metal immersed in pure water. We stated in the case of lead: "The positive electrode showed signs of slight oxidation, and the negative electrode a few small bubbles, in fifteen minutes; a slight cloudiness was then beginning to form, which afterwards increased; some oxide was found adhering in an hour, and afterwards gray metallic lead, which at the end of twenty-two hours was found to have stretched across to the positive electrode, forming a metallic connection which was so much heated by the passage of the voltaic current that the liquid became warm." We are informed that such lead crystals have sometimes been found in Faure's cells.

Supposing, however, that there is enough and to spare of sulphuric acid, the mixture of lead peroxide and lead-sulphate presents a double problem. Were we dealing with peroxide alone, it would be reduced on the one plate at the expense of two molecules of water or sulphuric acid, while at the opposite pole the oxygen would simply be liberated. But as there is always lead sulphate present, this liberated oxygen is mainly used up in oxidating that substance, and it is theoretically sufficient to peroxidise the two molecules of sulphate......These two molecules of $PbSO_4$ are obtained from one molecule of Pb_3O_4 (red lead), and it appears that two atoms of oxygen are sufficient to transform this into peroxide. But the corresponding amount of hydrogen (four atoms) by no means suffices to reduce a similar amount of red lead on the other side, for in this case both the peroxide and the sulphate formed by the action of the acid have to be reduced. To accomplish this at least eight atoms of hydrogen will be necessary, and this will demand the electrolysis of an additional two molecules of water or sulphuric acid. It might therefore be expected, *a priori*, that the minium on the side to be oxidated ought to be twice the amount of that to be reduced.

---

* Exhibited at the Paris Electrical Exhibition of last year.

† *Nature*, March 16th. For Part I. see ELEC. REV., page 21.

In order to ascertain what is the real course of procedure in charging a Faure battery, we took two plates of lead of equal size, and covered each with a known weight of minium, which was almost pure Pb_3O_4. We passed a current of known strength, about one ampère, through the arrangement for many hours, noting the amount of hydrogen gas which was liberated at the one pole, and the amount of oxygen liberated at the other. From the data it was easy to calculate the amount of electrolytic hydrogen and oxygen utilised. We performed the experiment several times, varying the strength of the current and some other circumstances. The most complete result was as follows:—

Time.	Hydrogen.		Oxygen.	
	Lost.	Absorbed.	Lost.	Absorbed.
Hours.	cc.	cc.	cc.	cc.
1	Nil	312	Nil	156
2	,,	318	18	141
3	,,	306	48	105
4	,,	300	66	84
5	,,	300	72	78
6	2	313	90	67
7	5	295	87	63
8	3	312	96	61
9	6	303	93	61
10	21	297	99	60
11	37	273	99	56
12	101	220	105	56
13	150	158	105	49
14	195	132	105	58
15	210	92	100	51
16	228	90	106	53
17	225	85	100	55
18	270	66	108	60
19	264	51	108	49
20	270	50	111	49
21	273	43	114	44
22	270	30	114	36
23	276	30	114	39
24	297	21	123	36
25	309	9	126	33
26	270	18	120	24
27	300	18	132	27
28	309	11	138	22
29	321	15	141	27
30	318	15	147	19
31	300	6	135	18
	5230	4489	3120	1737

The amounts of hydrogen and oxygen capable of being absorbed by the materials on the plates were 4,574 and 1,294 respectively.

We read the indications of this table in the following way:—At first, both the reduction and oxidation take place very perfectly, with little loss of either of the elements of water. The absorption of the hydrogen proceeds with little diminution, until by far the greater part of the lead peroxide and sulphate are reduced, but the last portions are very slowly attacked, probably because they are embedded in a mass of reduced lead. On the side that is being oxidated it is otherwise: a considerable waste of oxygen soon shows itself, but nevertheless a continuous slow absorption of that element takes place long after the theoretical amount of it has been fixed. A very small amount of this excess is to be attributed, according to our experiments, to the oxidation of the metallic plate itself. But we attribute the greater portion to the local action which must be constantly going on between the peroxide and the lead plate with the formation of sulphate of lead, the sulphate in its turn of course being attacked by the electrolytic oxygen. Thus the excess of oxygen in the fifth column of the above table may be looked on as a measure of the local action which has taken place during the charging, and the figures in the lower portion as roughly indicating its progress from hour to hour. Local action will of course take place at first on the opposite plate, but it requires no more hydrogen to reduce two molecules of lead sulphate than one molecule of lead peroxide, and the possibility of local action gradually diminishes as the reduction proceeds.

All our other experiments told the same story as far as the absorption of hydrogen is concerned, but there are differences on the other plate. In one or two instances, not half of the theoretical amount of oxygen was absorbed. On searching into the circumstances on which this depended, we were unable to arrive at any other conclusion than that it was connected with the condition of the surface of the lead plate.

Experiments with a current of about two ampères showed that a larger quantity of both hydrogen and oxygen was fixed in a given time, but there was a larger proportionate loss, especially in the case of oxygen. Experiments with a current of about half an ampère, on the contrary, gave a somewhat less rapid action, but a smaller waste of force through the escape of free gas.

A complete study of the results of these experiments would be instructive, but the following comparisons may suffice to illustrate the points just mentioned. The theoretical amount of oxygen required for the red lead used is about 1,200 cc., and the table shows the length of time in which 300, 600, and 1,000 cc. were fixed by different strengths of current, together with the accompanying loss:—

Strength of current.	Amount of oxygen stored.	Time.	Loss of oxygen.
Ampères.	cc.	Hours.	cc.
2	300	1·5	174
1	,,	2	18
½	,,	3·8	15
2	600	4·1	617
1	,,	5·5	249
½	,,	7·6	47
2	1000	13·9	3081
1	,,	12·2	900
½	,,	16·0	400

In some cases we mixed the red lead with a little water, and allowed it to dry. In other experiments we mixed it at once with dilute sulphuric acid, but without any particular practical advantage.

The forming of a good secondary battery is a matter evidently depending upon very nice adjustment of conditions. It is but a few of these that we have carefully studied; nevertheless, we feel ourselves in a position to make one or two suggestions in regard to the economic aspects of the question. It is evident that the energy stored up in a cell is determined mainly by the amount of peroxide present. This appears to be obtained with the smallest amount of waste when the current is not too strong; in fact, in our experiments it was obtained when the density of the current was about 6½ ampères, calculated on the original surface of the lead plates.

There would seem to be no commensurate advantage in continuing the current after the oxygen has ceased to be absorbed pretty freely, because the presence of some unoxidised sulphate of lead, although it increases the resistance, rather impedes than promotes local action.

On the other hand, however, it is necessary that the reduction of the minium on the opposing plate should be complete, for a mixture of lead peroxide and metallic lead would be peculiarly conducive to the production of lead sulphate, and thus increase the resistance; while if any peroxide should remain, it would diminish the electromotive force of the cell.

It would appear probable, therefore, that the most economical arrangement would be obtained by making the red lead to be hydrogenated much smaller in amount than that to be oxidated. On trying the experiment with only half the quantity, we obtained a most satisfactory result as far as the charging was concerned. How far such an arrangement may be really desirable, we hope to consider more fully when we treat of the chemistry of the discharge.

J. H. GLADSTONE,
March 9th. ALFRED TRIBE.

ELECTRIC LIGHTING FOR STREETS.

It is said that the Clerkenwell Vestry have entered into a contract with the Electric Light and Power Generator Company for the lighting of Pentonville Road with their incandescent lamps for one year. The cost of this lighting will be thrice that of gas, but ten times the amount of light is expected. Now that Edison's system will shortly be in operation on the Holborn Viaduct, we shall, if the above contract is carried out, soon have an opportunity of seeing experimental trials on a scale of sufficient magnitude to enable a definite judgment to be formed on the comparative economy of gas *versus* the electric light. In all other respects it is admitted that the electric incandescent light has the advantage, and it only remains to reduce it, light for light, below the present price of gas; for if contractors for lighting by electricity offer to put up large installations, or to light up streets at the same cost as is now paid for gas, the gas companies will immediately lower their present rates. That this now anxiously looked for result of the application of electric lighting will happen before very long we feel assured, as there are already several systems of incandescent electric lighting ready to compete with the present price of gas. However, all doubts will probably be set at rest on this score during the next three or four months.

On the Holborn Viaduct each globe will contain two of Edison's 16 candle-power lamps, thus giving a light equal to about 2½ ordinary gas burners. The carbon filaments manufactured for these lamps by Mr. Edison have a considerable reputation for durability, and we think that his representatives in this country will guarantee them to last 1,000 hours at the above-named candle-power. There is, therefore, no necessity to renew the lamps only at very long intervals, so that for all practical purposes we may consider that there is no consumption of material. The first cost of the lamps is also very trifling, so that this will not form a very important item in the total cost of lighting by such a system—that is, if the life of the carbon filaments come up to the guaranteed standard.

The real test will therefore resolve itself into one of comparing the cost of utilising coal in steam-engines for the production of the electric light as against its employment for making gas.

Referring to the contract for lighting the Pentonville Road by the Electric Light and Power Generator Company, the offer is to place two 50 candle Maxim incandescent lights in each of the existing lamps in the road, and to run them for ¾d. per double lamp of 100 candle-power per hour. The number of ordinary lamps to be replaced is 36, together with a large one of "Sugg's." The total number of incandescent double lights will be 38, the cost of which per hour at ¾d. each is 2s. 4½d., or for a total of 3,490 hours, £467 17s. 6d. The members of the committee when considering this question of lighting the Pentonville Road made a tour of those streets in the City which are now lighted by electricity, and it is curious to note the various estimates given to them by competing companies. Messrs. Siemens' six large lamps are estimated at 6,000, and the 28 smaller lamps at 300 candle-power each. The 34 arc lights of the Electric Light and Power Generator Company were calculated to give 1,200, and those of the Brush system (34 lamps), 2,000 candle-power each. In casually comparing in Cheapside the rival systems of Messrs. Siemens and Brush, one can only come to the conclusion that the former has been modestly given at a standard much too low, or that the other has been overestimated. We believe that all the electric light companies with the one exception we have mentioned declined to undertake the lighting by contract. Some were however willing to estimate on other terms, and the tenders may be of interest to our readers.

Abstract of Tenders received by the Special Committee for Lighting Pentonville Road by Electricity.

Name of Contractor.	To provide and fix Machinery, Lamps, &c.	To light for 12 months.	Total Cost.	Number of Electric Arc Lights.	Number of Gas Lamps done away.	Cost of Gas for the 12 months.	Remarks.
	£ s. d.	£ s. d.	£ s. d.			£ s. d.	
Crompton & Co.	986 10 0	676 0 0	1,662 10 0	12 (3,500 to 4,000 candles each.)	54	158 12 5	Over-head wires.
British Electric Light Co., Limited	2,340 0 0	1,673 0 0	4,013 0 0	20 (2,000 candles each.)	54	158 12 5	3,650 hours. If this number be exceeded the price would be 9s. per hour. If lights abandoned at end of year, Vestry to pay £300 towards cost of removal of machinery, &c.
Hammond & Co.... ...	1,337 9 4	477 3 10	1,814 13 2	12 (2,000 candles each.)	54	158 12 5	Over-head wires. 3,650 hours. This machine would work 16 lights, 4 of which might be let out as private lights.

The Anglo-American Brush Electric Light Corporation finding themselves unable to tender for a period of twelve months, offered, however, to supply the necessary apparatus and instruct any men the Clerkenwell Vestry might appoint to work the same. The estimate for this was as follows :—

	£	s.	d.
1 No. 7a dynamo-electric machine - - -	400	0	0
16 lamps of 2,000 candle-power, to burn from 14 to 16 hours, at £16- - - - -	256	0	0
16 city hoods and frames, at £5 - - -	80	0	0
16 weather protectors, at 5s. - - -	4	0	0
16 best alabastrine globes, at £1 1s. - -	16	16	0
480 yards cable on columns, at 2s. - - -	48	0	0
2,200 yards of insulated cable, for conducting current to and from machine, including piping, &c.	715	0	0
Tachymètre, for showing speed of dynamo, as regularity on this point is important, and fixing	15	0	0
Sundries - - - - - -	50	0	0
Packing, carriage, and installation - - -	actual cost		
Total - - -	£1,584	16	0

The accepted tender for lighting the Pentonville Road seems to us rather low for the amount of illumination to be produced, and we hope that the contracting company will be more successful in applying incandescent lamps than it has been in the employment of the arc lights for the City. It will be most interesting to learn whether the Maxim lamps will stand for any length of time at the temperature necessary for producing a power of 50 candles, for although in their construction the chances in this respect are in their favour as against other systems of lighting by incandescence, we have yet to prove practically that they can be depended on outside the laboratory, and away from skilled manipulation and supervision. Electric lighting has one great advantage as compared with gas which we do not think has yet been touched upon when speaking of both. If we burn five feet of gas per hour, and get a light of say fifteen candles, we only double our light by a twofold increase of our gas, and for three times the consumption, only three times the light. With the electric light, as shown by Mr. Swan in his recent lecture, the case is entirely different. Thus in the following table we see the enormous increase of illuminating power as we double and treble our unit of current :—

Current in Ampères.	Electromotive Force in Volts.	Candle-Power Produced.
·5	35	0 (carbon red-hot, but no light)
1·0	60	2 „ „
1·5	88	35 „ „

It is now well known that to work incandescent lamps with carbon filaments in the most economical way, it is necessary that they should be raised to the highest possible temperature compatible with safety. The Maxim lamp is, as far as we are aware, the only one in which a strong current can be used, and we have every desire for the success of this, the most recent of proposed experiments in street electric lighting. Without reckoning interest and depreciation on cost of plant, or anything for lubricants and attendance for engines and machines, the whole of the sum of £467 17s. 6d. will be, we think, absorbed in coal alone for the production of the stated light, by means of the incandescent system.

ON PHOTOMETERS.

I.

AN essential requisite to the proper comparison of different systems of electric lighting is a knowledge of the relative illuminating powers of the lights themselves. We consider, therefore, that it is strictly within the objects of this journal to embrace so much of the science of photometry as will enable our readers either to construct for themselves, or to select with discrimination, such apparatus as will best serve their wants. An increased demand for photometers, and the need of an increased degree of accuracy, will in all probability result, at no distant date, in the invention of methods and apparatus superior to those with which we are at present familiar. Photometry is a field which has hitherto offered small scope to the ambition of the professional inventor; indeed a patent for a photometer would scarcely be likely even to return the fees which it cost, so limited has hitherto been the demand for such instruments. The rapidly increasing commercial application of light will, however, soon produce advances in methods and apparatus of photometric research, just as the commercial application of telegraphy gave an impetus to the invention of apparatus for electrical measurement. Starting from the standpoint that a perfect photometer has still to be invented, we propose to describe as clearly as we can those which are at present in use, and some also of those which have been suggested and tried, but have fallen into disuse.

The methods employed in photometric comparisons are three, viz:—1. Estimation by the eye; 2. By means of absorbed heat; and, 3. By photo-chemical action.

The most common method is, of course, estimation by the eye, than which no test can be more delicate or trustworthy to declare the equality or inequality of two illuminated surfaces—such as of two white discs, or even of two surfaces of the same simple colour. Under favourable circumstances of light and relative position, the point of equality of illumination between two neighbouring and similarly coloured surfaces can be estimated by the eye to within 1 per cent. On the other hand, when we come to compare by means of the eye the degrees of illumination of otherwise similar surfaces by differently coloured sources of light, it must be distinctly understood that such comparisons have strictly speaking only a physiological value peculiar to each individual observer, and afford no reliable evidence of the objective strength of the sources of light themselves. Some more or less refined methods have been suggested of comparing the spectra of differently coloured sources of light, and some more or less clumsy methods of interposing coloured glasses in the field of view of the illuminated surfaces under comparison. But neither device mends matters much, and we come back still to the fact that strict photometric accuracy with any of the generally available methods of procedure ends where different colours enter into the comparison. A momentary consideration of the nature of light must make this sufficiently obvious.

The human eye is so constructed that it can convey to the brain sensations corresponding to etherial vibrations ranging through about half an octave, and which sensations we call light. A little way outside this half octave of sensitiveness, either higher or lower in the scale, is perfect darkness for all of us, while within the small range in question one observer may be more sensitive to the higher, while the brain of another may have more sympathy for the lower notes which strike upon their respective organs of vision. The present writer happens to be partly colour-blind for green, so that a green light means for him only a dirty or obscured light, but he is sensitive to some other colours. A friend of ours is insensitive to the violet end of the spectrum, which looks to him cloudy and neutral in tint, while he is fully alive to green. Now suppose a third observer, with perfectly normal vision, to adjust a photometer to a balance between a bluish and a greenish light. The writer in verifying the adjustment would pronounce the bluish light to be too strong, while his friend would pronounce the adjustment to be wrong the other way. In observations by means so purely subjective it is evident that great caution should be exercised and great latitude given for the physiological peculiarities of the chief part of the available measuring apparatus; that is to say, the eye of the observer, in all cases where the slightest dissimilarity exists in respect of colour.

The light of any luminous source being propagated around it in all directions, it naturally follows that its power of illuminating any object must decrease when the distance of the object is increased; the same rays which cover a square foot of surface at one yard distance would be distributed over and cover four square feet of surface at a distance of two yards, or nine square feet at three yards. And it follows from this alone, without any special experimental proof, that illumination by a source of light must decrease as the square of the distance from it increases. Put algebraically, if L is the illuminating power of the source of light, and d its distance from a suitable object, the degree of illumination i of the object may be expressed by

$$i = \frac{L}{d^2}$$

The illuminating power of a light in respect of an object depends not only upon the intensity of the light and its distance from the object illuminated, but also upon the extent or area of the luminous surface. In treating of photometric determinations, a loose mode of expression is sometimes employed which should be avoided. We frequently, for instance, hear such statements as that the intensity of two candles is double the intensity of one candle. Now as a matter of fact the intensity of one candle flame is precisely the same as that of any number of similar candle flames; but the illuminating power of a number of candles is *cæteris paribus* proportional to their number. Assuming that the intensity of a given flame is λ, and that the apparent area of its luminous surface is a, its illuminating power will be $a\lambda$, while the degree of illumination of, or the quantity of light which falls upon, a unit surface of a suitable object at the distance d, will be

$$\frac{a\lambda}{d^2}$$

and the degree of illumination of the same object, when n such flames are employed in the place of the single flame will necessarily be

$$\frac{na\lambda}{d^2}$$

In that branch of photometry which depends upon estimation by the eye, all the different methods depend upon a common principle, viz., the weakening of the effect of the stronger light till it becomes in some way equivalent to the weaker light. If the relation between two sources of light whose degrees of brightness or illuminating powers are respectively L and l, the effect of the brighter light has to be weakened to $\frac{1}{m}$th, by any of the means which will be described later on, until the effect of l is balanced by it, and we get the equation, $L = lm$.

It is in the means by which the weakening of the brighter light is effected in a known degree that the different methods of photometry by occular estimation consist.

The earliest recorded suggestion of a method of photometry is said to be that of a Frenchman named Bouguer,* who in the early part of the 18th century described the method of illuminating two white surfaces with the two lights which he wished to compare, in such a way that he could see them in perspective near together. He then increased the distance of one white surface from the source of light, which fell upon it till both surfaces appeared equally illuminated. In 1760 Lambert, in his work "Photometria," suggested the comparison of two sources of light by the comparison of the shadows of an opaque rod which they cast upon a white screen. He altered the distance of the stronger light until the shadows became equal.

---

* "Traité d'Optique sur la Gradation de la Lumière." Paris, 1760.

REVIEW.

Elementary Lessons in Electricity and Magnetism. By SILVANUS P. THOMPSON. London: Macmillan & Co.

SCIENTIFIC literature is now so rich in books treating of electricity and magnetism, that the publication of any new treatise on the subject can only be justified if the new work contains either a considerable amount of new matter or if it treats of the general subject in such a novel way as to render it more intelligible to the reader than any other previous work has done. To merely repeat in slightly new phraseology what has been said over and over again can hardly be said to constitute a new work of value. In Professor Thompson's handy little volume there is in the first 150 pages or so but little which is not contained in existing text-books on electricity, but this little has brought the matter into modern form, more especially with regard to the use of the electrical units. The explanations as to why the units have their particular values are given in the usual way, *i.e.*, in such a manner as to afford little, if any, enlightenment to the general student. We have never yet seen any explanation of the C. S. G. system of units which is satisfactory. The question is a great stumbling-block to beginners, who either want to know all about the matter, or at least would like to have some kind of familiar explanation which may give them a notion of what it all means.

The learner reads about magnetic poles of unit strength, and when he tries to find what the unit strength means he expects to be told that it is a strength that will support a definite weight; but instead of this he finds it stated that "a unit magnetic pole is one of such a strength that when placed at a distance of one centimetre from a similar pole of equal strength it repels it with a force of one degree," an explanation which leaves the inquirer just as much in the dark as ever. As a rule, a beginner cannot grasp the meaning of such explanations unless numerical examples are given. Tell him that the unit of work is that effected by the unit weight falling through the unit distance, and he is just as wise as he was before the explanation was given; but explain that the unit of work is that done by a pound weight raised through a distance of one foot, and he at once sees what is meant. The meaning of the earth's horizontal magnetic force, whose value in absolute units is 1·788, has often been asked by inquirers, but we must confess we have never yet seen an explanation which will enlighten them on the subject. If we refer to the question on p. 281 of Professor Thompson's work, we are treated to a number of equations, and the connection between these is shown, but that is all; no numerical example is given, and the student, who by the aid of such an example would probably understand what is being explained, is almost as wise as he was before reading the chapter. We cannot too strongly insist upon the value of numerical examples in helping students to understand what is attempted to be taught them. In many cases in Professor Thompson's book numerical examples are given, but as a rule these cases are those in which such examples are the least necessary for explaining what is meant.

The chapter devoted to the electric telegraph consists of only a few pages, and contains brief descriptions of the single needle, the Morse instrument, &c. The explanations are correct, so far as they go, but why, we ask, does Professor Thompson follow the ridiculous practice of making the illustrations of the instruments as much unlike the actual form as possible? The instruments which are employed at the present day have assumed definite forms, which practice has proved to be the best, and why drawings could not have been made from such instruments it is difficult to say. Such defects as these, although they might have been avoided with advantage, do not detract from the value of the book, which we think is likely to prove very useful to beginners.

THE ELECTRIC LIGHT IN ST. LUKE'S.—At the meeting of the St. Luke's vestry, held last night at the Vestry Hall, City Road, Mr. Churchwarden Moreland chairman, Mr. Whiting moved that it be referred to the General Purposes Committee to inquire into the cost of lighting the main thoroughfares of the parish with the electric light, which was agreed to without opposition.

CORRESPONDENCE.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number.

TECHNICAL EDUCATION.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—I have read with interest your leader on the above subject, and also your previous article on "Unscientific Electric Lighting," and it would seem that the statements contained in the latter article fully justify the attempts that are being made to make technical education as widespread as possible. The object of the City and Guilds of London Institute is, I understand, to give technical education not only to those who are to act as supervisors of technical work, but also to those who are to be supervised, *i.e.*, the working men, the idea being that the better the education the better will be the work turned out. This idea it seems to me ought to be a truism, but I ask, Is it so? Where are the proofs? Let us first consider which of the nations is the most advanced in practical science. In Russia, I believe, no person can practise as an engineer or engage in any work allied to engineering unless he has passed through a course of university training and has taken a diploma. What standing, I would ask, has Russia in the scientific world? Let us next consider Germany. Here technical and general scientific training is, I believe, considered to be carried to the highest perfection, yet where are the vastly superior results which have followed from this high training? As regards electrical engineering, to what nation is due the enormous network of cables which has spread over all the world, and has the bulk of the work been carried out by men who have been pre-eminently noted for the high honours which they have taken at a university or elsewhere? In England technical education has hitherto practically been neglected, and if we look over the laboratories and workshops of those institutions where some attempt has been made to carry out technical education, we certainly should not be struck by their completeness when they are compared with the elaborate establishments which we hear of in Germany.

In France, the employés in the telegraph service are required to pass an examination which would make the hair of the English or American telegraph operator stand on end; yet can it be said that the latter carry on their work in a less efficient or satisfactory way than their French confrères? I would go even further, and would say that not 75 per cent. of the technical engineering staff employed in the Postal Telegraph Department of Great Britain would be able to pass the examination which it is required that the French telegraph clerk shall pass; yet I state emphatically that in practical knowledge of his work the English postal telegraph engineer will hold his own against any foreign rival. The construction of their lines are excellent, the arrangements of the offices and the details in the construction of the apparatus are such that more than one European government has asked for full information on the subject, and has in some cases adopted the apparatus for use on their lines. Does this point to the overwhelming advantages of a high standard of education?

Did the pioneer of railways, George Stephenson, make his way in consequence of the advantages which he had derived from a course of mental training? Supposing that the Russian system to which I have alluded had been in vogue then, would George Stephenson have risen above the level of an ordinary workman? Many, if not most of the inventors of the present day, with a very few exceptions, have been men who have risen from the ranks, and that not as a consequence of the high educational advantages which they have had. As regards workmen, I believe it is unquestionable that those who are most skilled in their work are those whose general education has been most neglected. Take any mechanical workshop, and I will undertake to say that the most skilful mechanic will certainly not be the man who has received the best education.

As regards education generally, it is notorious that the great majority of those men who have taken the highest university honours have made no mark in the world.

The object of technical education in this country is to enable us to keep pace with the rest of the world; but we require proofs that technical education will have this desired result, and I submit that if we have any proofs they are not in favour of such education.

A SCEPTIC.

[The question of education generally, and of technical education in particular, is so important, that we should be glad if any of our correspondents would offer remarks on the subject.—ED. ELEC. REV.]

ARC *V.* INCANDESCENCE.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—We are informed that the resistance of Edison's 16-candle incandescent lamps when cold is 350 ohms, when hot 125 ohms. We are also informed that the resistance of Brush's 2,000-candle arc lights in circuit is $4\frac{1}{2}$ ohms per single arc light, or $4\frac{1}{2} \times 16 = 72$ ohms for 16 lamps in circuit. This shows more resistance for one Edison 16-candle lamp than for 16 Brush 2,000-candle light.

How is this? Is the electromotive force for one Edison incandescent lamp greater than the electromotive force for sixteen Brush arc lights? If so, the economy of the arc light is very manifest. Hoping that some of your correspondents may explain this apparent anomaly,

I am, &c.,

T. P. BARKAS.

Newcastle-on-Tyne, *March 16th*, 1882.

[Edison's incandescent electric lamps are used in a parallel circuit, the electromotive force between the terminals of each lamp being about 110 volts, and the strength of current passing through about 1·25 ampères. We think you have been misinformed as to their resistance. As a rule, we believe, they average about 150 ohms when cold, and 70 or so when heated to 16 candle-power, but they vary considerably. The electromotive force between the terminals of any single Brush lamp is about 50 volts. The amount of candle-power per horse-power of the arc system as compared with incandescence is about eight or ten times in favour of the former; but it must not be forgotten that in the latter system there is practically no waste of material, whilst the cost of carbon forms a large item in arc lamps. The "apparent anomaly" is explained by the fact that in incandescent lighting we have not any material at command to stand without fusion the strength of current that we can pass through the arc. The Maxim lamps have been worked as high as 1,100 candles per horse-power, but they do not last beyond a few hours.—ED. ELEC. REV.]

THE ACTION OF THE TELEPHONE.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—Mr. Strangways' arguments which he brings forward to prove that the articulating telephone can work by a make-and-break action are, in my opinion, entirely false. At the commencement of his letter the writer says: "Now it is impossible for any one to allege that the secondary current from an induction coil is in any way analogous in its nature to what Bell describes as an undulatory current; and unless all our previous investigators have been altogether in the wrong as to the action of the induction coil, the current generated in the secondary is instantaneous only, whatever may be the direction in which it may flow." Mr. Strangways is entirely in error here, the current generated in the secondary wire of an induction coil is "instantaneous" only when the make-and-break action takes place in the primary. I use the word "instantaneous" here advisedly, for, strictly speaking, the word "instantaneous" is incorrect, as it means "absence of time," whereas the very fact of a current existing means that it passes for a definite period. If Mr. Strangways will take an induction coil and for a lengthened period (comparatively), say, of five seconds, will send through the primary coil a current whose strength continually and uniformly diminishes or increases, he will find that so far from getting what he calls an instantaneous current in the secondary, he will get for that period of five seconds a *continuous and uniform current*, and moreover, if the variation in the primary current be irregular instead of uniform, then the current in the secondary will be irregular in sympathy. No instrument illustrates the flow of the current in the secondary wires of an induction coil so instructively as does the Bain chemical recorder. Let Mr. Strangways connect the secondary wires of an induction coil to the metal roller and stylus respectively of a Bain instrument, and then let him send makes and breaks, and also *variations* of current through the primary, and I think he will be convinced that he has written rather hastily, and that the secondary current from an induction coil *can* be, and in the case of the telephone apparatus *is*, undulatory.

Mr. Strangways says: "The idea of an undulatory current is that of a current passing continually without ceasing, but varying in quantity or power." This is certainly not correct, for according to Mr. Strangways if we have, say, a uniform series of waves whose crests are due to a potential of 8 volts, and whose depressions are due to a potential of 5 volts, then, although the forms of the waves would be exactly similar if the crests were due to a potential of 8 — 5, or 3 volts, and their depressions to a potential of of 5 — 5, or 0 volts, the waves in the latter case could not be waves, because their depressions are at a point where there is no potential, *i.e.*, where no current flows.

On referring to Mr. Strangways' first letter, I find the following:—"I find that the average compass of the human voice is about two (2) octaves, varying from 87 to 775 vibrations per second, so that by make-and-break you can transmit a number of currents of electricity per second, both fewer and greater than the number of vibrations to be found in the full compass of the human voice. This being so, why cannot make-and-break transmit and reproduce the human voice in the telephone?" I must confess that it is hardly credible that Mr. Strangways can really mean this as an argument. It amounts to this, that because a railway train and carriage can both travel at a rate of from 1 to 10 miles an hour that, therefore, if the carriage pursues a sinuous course along the road, the railway train can do the same also on its rails.

Yours faithfully,

March 20th. TELEPHONE.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—In my former letters I have endeavoured to establish the propositions that the telephone receiver will reproduce human speech when such receiver is actuated by a make-and-break current, or a current of the nature of a make-and-break current; and it is now necessary to consider whether such a current is, or can be, transmitted by a hard carbon microphone when articulate speech is being transmitted. I assume the following premisses, and as they are truisms in terms, I apprehend that they will not be questioned. First, "make" is "make," and "break" is "break;" second, "contact" is "contact," and "no contact" is "no contact"—that is to say, if two substances touch one another they do touch one another; and if they do not touch one another there is some space, however small, between them.

Edison's claim is for the "combination with a diaphragm or tympan of electric tension regulators substantially, as hereinbefore described, for varying the resistance in a closed circuit;" and it is quite clear that any instrument working by make-and-break is not within his claim, as set out above. Moreover, if Edison's soft carbon transmitter works by make-and-break, it is really only Reiss's old transmitter with carbon substituted for platinum. It is consequently necessary that Edison should maintain that his transmitters work only as tension regulators in a closed circuit; and, in order to bring the hard carbon microphones within his patent, he has to allege that they also act only as tension regulators in a closed circuit. A reference to Edison's patents and to the published accounts of his inventions will show that, up to the time of Hughes' discovery of the microphone, Edison was working on the basis of the varying resistance of substances when under pressure; and he probably was led to do this from a belief in Bell's account of his undulatory current. Prescott, in his book on the telephone, gives descriptions of a large number of Edison's instruments;

and, apart from the telephone apparatus, it can readily be seen that Edison's micro-tasimeter and his carbon rheostat are both based on the varying resistance of soft carbon when under pressure, and that it was the varying resistance of substances when under pressure, and that only, that was engaging his attention prior to the discovery announced by Hughes. That Hughes may have been made aware of the nature of Edison's investigations, and that it was in pursuing those investigations that Hughes discovered the microphone, is very likely; but it by no means follows that Hughes' hard carbon microphone works in the same manner as Edison's soft carbon telephone transmitter. When Hughes exhibited and explained his microphone before the Society of Telegraph Engineers and Electricians, Preece said that he believed that the microphone worked by loose contacts. Now "loose contacts" is a loose phrase: it is capable of several different meanings, and would cover the mode of action now attributed to Edison's soft carbon telephone, as well as that of the make-and-break transmitter of Reiss.

It has long been known that all hard carbon microphones oxidise at the points of contact; but as far as is known, the passage of the current through a piece of hard carbon will not cause it to oxidise unless the current is strong enough to raise it to a very high temperature, whilst the oxidation at the points of contact in a microphone takes place without any perceptible rise in the temperature of the carbon. If the microphone is so sensitive that a spark can sometimes be seen at the contact points, this oxidation is very rapid; and even in a microphone which is not very sensitive, and in which a spark cannot be seen at the contact points, the oxidation takes place after only a few hours' use; and in a microphone in which the contact is made between a flat surface and a knife edge, the oxidation assumes the appearance of a reddish-brown line on the flat surface of the carbon, and when this oxidation has proceeded to some extent the microphone ceases to act.

The extent of the movements which sound vibrations produce in different substances has been measured, and it has been demonstrated that sound vibrations do produce a movement in the surface of a body through which those sound vibrations are passing, or against which they strike. It has also been repeatedly demonstrated that the voltaic current will not pass over any break, however slight, that there may be in a circuit, unless such voltaic current is of very high intensity, and unless contact has been made, when, on the circuit being broken, an arc is, with a strong current, formed; but when the arc is formed, the current continues to pass, and a current so passing is not that described by Bell as an undulatory current. Yet with these well-known facts before us, facts which it appears to me will fully explain the action of the microphone and telephone when transmitting and reproducing human speech, it is sought to establish new theories, which theories are, if I am right in my views, unnecessary as explanations of the action of the microphone and telephone, are inconsistent with well-known facts, and are utterly unsound in their nature.

The mode of action of the soft carbon telephone was not, at the recent trial, in dispute between the parties, but it was contended that the hard carbon microphone worked in the same way; and it was decided by Lord Maclaren, mainly on the evidence and opinion of "the most eminent electrician in the United Kingdom," "that the principle and mode of action of Edison's tension regulator and that of the respondent is one and the same. If the respondent's surfaces vary the resistance by make-and-break, so must Mr. Edison's." The above assumption is a simple one; it means, I do not understand the instruments, but "Cæsar and Pompey are very much alike, especially Pompey." The assumption is, however, altogether incorrect on the face of it; for if the microphone transmitter works by make-and-break there is not any varying of the resistance in the circuit, but there is an absolute cessation of the current in each break, and an instrument so working does not vary the resistance in a closed circuit, and is consequently not claimed in Edison's patent.

It appeared to me, on reading the evidence given for the complaining company, that if their explanation of the action of the microphone was correct, substances that would yield slightly to pressure might be made good microphones. I therefore made a microphone of two pieces of wood at right angles to one another, and in the vertical piece fixed, at a distance of about an inch apart, two pieces of ⅜-inch brass rod, each about $\frac{3}{16}$ long. In the bottom one a small hole was made with the point of a drill, a little longer than the mark of a centre-punch, and through the other was drilled a hole about ⅛ of an inch in diameter. The edges of this hole were cut away in the lathe, so that anything put through this hole would touch in the middle only. These pieces of brass were tied to the vertical piece of wood by copper wire, the piece with the hole through it being at the top, and a terminal connected to each piece, so that any conducting substance put through the upper piece of brass, and allowed to rest in the drill mark in the bottom piece, would complete the microphone. The vertical piece of wood carrying these brasses moved on a pivot, so that it could be set at any angle, and the pressure of the rods or wires thereby altered. It appeared to me also that if the view that the microphone acts by the compressibility of the substance of which it is constructed is correct, it would follow that a microphone composed entirely of brass should act better than a microphone of precisely similar design composed of hard carbon; whilst if the view that the microphone acts by make-and-break is correct, a microphone made of brass would do little more than transmit some of the lower notes, and the power of a microphone to transmit the higher notes would increase as the substance of which the microphone was made increased in hardness, and consequently decreased in compressibility.

I tried the microphone described above by putting thin rods of the various substances, pointed at one end, through the hole in the upper brass, and allowing them to rest in the small hollow in the lower brass. The following were the results. Brass and brass produced the lower notes of a musical box, with only one or two of the higher notes, a Bell telephone being sometimes used as a receiver, and at other times one of the little electro-magnet receivers; iron and brass produced the lower notes better than before, and a few more of the higher notes; steel and brass was a great improvement, and carbon and brass a further advance; but still the reproduction was very unsatisfactory, and the tone in the telephone unpleasant. One of the rods used consisted of a sewing needle, and when this needle was threaded, and the thread allowed to rest on the wood of the microphone, no sound at all was produced in the telephone. With none of these materials was speech reproduced, and only a few tones of the human voice. I then removed the two pieces of brass from the vertical plate of the microphone, and substituted two pieces of hard carbon, prepared in a manner quite similar to, and of the same size as, the brasses, and the results were that brass and carbon were about similar to carbon and brass; iron and carbon a great improvement; steel and carbon a further improvement; and carbon and carbon as good an articulating microphone as any one could desire. It has recently been stated several times in the ELECTRICAL REVIEW that hard carbon does not vary in its resistance when under pressure; and it will be seen from the foregoing experiments that the transmitting power of the microphone gradually increased and improved as the substances of which the microphone was composed were harder in their nature: that the worst substances were brass on brass, the softest and the most compressible of the substances, and that the best (indeed its articulation was so clear that I may say it was a perfect microphone) was the one constructed of the hardest and most incompressible of the substances. In each of these experiments, by attaching a thread of cotton to the rod, and allowing such thread to rest on the wood of the microphone, the transmitting power at once ceased, showing apparently that unrestricted motion is necessary in one piece of a microphone, although the motion required is infinitesimally small, and that if the parts of a microphone are kept in contact, such microphone will not work; whilst if the hard carbon microphone works as a tension regulator in a closed circuit, unrestricted motion is not necessary, and the retention of the parts in actual contact would not only be an improvement, but would be a condition essential to the ability of the microphone to transmit human speech.

I think it is clear that the current generated by a Bell telephone, when acting as a transmitter, is not of the nature of the current described by Bell as an undulatory current, nor is the current transmitted by an induction coil; and as the telephone receiver will act with these currents, which are both of the nature of make-and-break currents, and will when so acting reproduce human speech, it would follow that, unless there is some other cause to prevent it, human speech may be transmitted by a microphone acting on the make-and-break principle. If I have shown this to be the case, and that all the variations in the amplitude of the vibrations of the armature plate of the telephone receiver, which armature vibrates under restraint, can be produced by a make-and-break current, I have succeeded in the object that I had in view when I commenced these letters.

I may, before concluding, mention that the cup-and-ball microphone may be reversed in its construction, that is, instead of two conical cups and a round ball, you may use two conical pegs and a ring—the pegs being cut out of $\frac{3}{16}$, and the ring out of $\frac{3}{8}$-inch carbon rod.

I am, Sir,
5, Pump Court, Your obedient servant,
Temple, E.C., H. B. T. STRANGWAYS.
March 21*st*, 1882.

THE ELECTRICAL RESISTANCE OF CARBON UNDER PRESSURE.

To the Editor of THE ELECTRICAL REVIEW.

SIR,—I am indebted to Mr. Herbert Tomlinson for drawing my attention to his most interesting comparisons between the behaviour of carbon and of metals in respect of change of electric resistance under mechanical stress, and am glad to see that his delicate determinations entirely bear out my conclusion that the excessively slight change of specific conductivity produced by stress in hard coke carbon cannot possibly explain the great variations of resistance observed in the carbon telephone, carbon rheostat, &c. I have also learned that a similar conclusion was arrived at some time ago by Professors Naccari and Pagliani, and that some experiments made by Professor W. F. Barrett, of Dublin, on the buttons of compressed lamp-black, prepared in Edison's laboratory for use in his well-known carbon telephone, lead to a precisely similar result. I am therefore perfectly willing to admit that before the publication of my experiments this question was virtually settled. It is quite clear that the carbon telephone does not work by any variation in the specific resistance of the carbon, but by the partial opening and closing of the circuit at certain surfaces, where the intimacy of the contact can be varied by the vibrations of the voice.—Yours, &c.,

SILVANUS P. THOMPSON.
Bristol, *March* 20*th*, 1882.

NOTES.

THE MICROPHONIC ACTION OF THE SELENIUM CELL.—By J. Moser.—At the beginning of his researches the author shared the general view that there exist two kinds of photophones, and three kinds of light-rays. He conjectured that the selenium photophone might give a clue to an immediate relation between light and electricity. His investigations have led him to the simpler conviction that a microphonic action is present in the photophone. The selenium photophone is in principle merely a microphone, and agrees most closely with that form which has been described as a thermoscope. Generally speaking the rays of light can produce modifications in selenium, but these are not essential for the selenium photophone. There exists only one kind of light-rays, although of different wave-lengths and intensities. One and the same ray can act thermically, luminously, and chemically, and it has only one kind of photophonic action. Hence the author sees no reason for distinguishing selenium from all other bodies on account of its photophonic action, and no longer entertains the hope of discovering in the selenium-photophone a new connection of the natural forces.—*Carl's Repertorium.*

KRÖTTLINGER'S DYNAMO-ELECTRIC MACHINE, DRIVEN BY HAND, FOR LABORATORY PURPOSES.—Last summer I had the opportunity of closely examining an electro-dynamic machine constructed by the mechanician Kröttlinger, of Vienna, and exhibited at the Congress of German Naturalists and Physicians at Salzburg. It deserves a wider use from the following reasons: it yields a current sufficient for most lecture experiments; it can be easily kept in motion by a man, and its price is so moderate that it can be easily procured by intermediate schools. The entire apparatus consists of a strong wooden table, between the feet of which the machine is fixed. Under the leaf of the table is a steel axle for the fly-wheel, which is connected by an endless belt with the axle of the Gramme inductor, so that the latter can be thrown into very rapid rotation. The exciting horse-shoe electro-magnet has at its poles iron appendages which extend into the interior of the Gramme inductor in the same manner as is done by Fein in his large machines. (See *Repertorium*, 17, p. 579.) The ends of the wires are brought to the binding screws, in which the conducting wires of the connecting arc are introduced. A very useful appendage is the rheostat placed upon a board at the side of the table. It consists of a fine wire bent in a zigzag form, any given length of which may be introduced as a branch-conduction by turning the handle, L, over the knobs placed beneath it. Among the many experiments which I have made with this machine a few may receive especial notice. An electric lamp on Reynier's system yielded a sufficiently intense light to carry out successfully projections with Stœhrer's sciopticon. A thin platinum wire 50 centimetres in length can be heated to whiteness. The inductor of a Gramme hand-machine with steel magnets, from which the toothed wheel had been removed, was kept in rapid rotation by Kröttlinger's machine, so that the principle of the transportation of power by means of electricity could be very clearly demonstrated in the lecture-hall.—*Carl's Repertorium.*

PLAN OF A TELEMETEOROGRAPH.—By Dr. Paul Schreiber.—The author's proposed arrangement for what may be called an automatic and self-registering meteorological observatory consists of a barometer, two thermometers, a weather-cock, and a Robinson anemometer. One of the thermometers is protected against radiation and moisture, whilst the other is arranged as a wet-bulb instrument, or, as this might be difficult to effect, freely exposed. The apparatus records its own results upon rolls of paper by means of needles, every hour, and despatches them telegraphically once daily, or more frequently, to any required place.

The apparatus has not been brought into action, but all the principles of construction involved have met with application elsewhere and have been found practical. The apparatus can work even under the most unfavourable conditions, whilst an interruption in the telegraphic communication has no influence upon the registration.—*Carl's Repertorium.*

ON THE EXISTENCE OF A DIELECTRIC POLARISATION IN ELECTROLYTES.—By R. Colley, of Kasan.—The occurrences in electrolytes during the transit of the galvanic current have been latterly the subject of many researches, and have been considered from different points of view. In an earlier memoir (*Wiedemann's Annalen*, 7, p. 206, 1879), I think I have shown experimentally that the galvanic decomposition cell, viewed as a system of condensers, must not be regarded as a condenser in which the electrolyte plays the part of a dielectric with a very great dielectric constant, but that, according to the more correct view, each electrode is an independent condenser, whilst the electrolyte is a conductor.

Helmholtz, who first brought forward this latter view, has latterly (*Wiedemann's Annalen*, 7, p. 337, 1879) introduced the idea of an electric double stratum for the electrodes. By an abrupt change of potential between two closely adjacent strata of corporeal molecules there is occasioned upon them an accumulation of electricity. Such a double stratum, therefore, acts like a condenser introduced into the circuit. But, though the galvanic polarisation (a process absolutely confined to the surface of the electrodes) has nothing in common with the dielectric, this is not a proof that the latter does not exist in electrolytes, as in conductive bodies in general. According to the ideas represented by Faraday and Maxwell by the action of electromotive force upon any body, so long as it is not an absolute insulator, there is produced in it both conduction and distribution, or dielectric tension.

It is further to be considered that there is no sharp line to be drawn between conductors and non-conductors. It is scarcely to be thought that in a class of chemically analogous bodies, as, *e.g.*, in the fatty acids, the lower homologues, like formic and acetic acids, are electrolytes, whilst the higher, such as stearic acid, are dielectrics without the intermediate members, or rather all the members, of the series exhibiting a mixed character. The difference seems to be quantitative rather than qualitative, and lies simply herein that in the extreme members of the series the properties of the one or the other class of bodies are more prominent. It seemed to me, therefore, not unimportant to examine a series of bodies in which the extreme members are dielectrics, or on the other hand conductors (electrolytes) and manifest the well-known phenomena of dielectric or of galvanic polarisation, whilst the intermediate members belong indeed chemically to the electrolytes, but are only moderately good conductors of electricity. The results of the author's experimental researches give a new confirmation of the correctness of the ideas upheld by Faraday and Maxwell. Dielectric polarisation exists not only in insulators but in conductors. This is especially demonstrated for decomposable conductors. Galvanic and dielectric polarisation have nothing in common, since both phenomena may co-exist in one and the same body. The dielectric constants of electrolytically conductive bodies belong to the same order of magnitude as those of the true dielectrics.—*Wiedemann's Annalen.*

Experiments made with M. Faure's Secondary Batteries.—We find that the slight errors in some of the columns of figures in the article we published last week are merely typographical, and do not affect the results there shown.

Military Telegraphs.—Mr. W. R. Plum, one of the most active telegraph officers serving in the late American war under Major-General G. H. Thomas, and now attorney in Chicago, U. S. A., has during some years been engaged in writing a History of Military Telegraphs employed during the above-mentioned war. Unfortunately Mr. Plum has been prevented by overwork and consequent illness from publishing his book at an earlier date. We are happy to congratulate the author, not only on the restoration of his health, but also on the completion of the work. The history consists of two volumes; the first is already printed, and the second will be shortly issued. We anticipate that this work will not only be of great value as an historical contribution to military literature, but will considerably assist the solving of the all-important question in military telegraphy, as to whether field telegraphs should only be used for strategical purposes at the rear of head-quarters, or for the more important service of tactical operations in the front of the enemy.

The American army set the example before any other had thought of utilising the field telegraph in front of the enemy. We think that the statements and reports from such a distinguished officer will prove exceedingly useful to the field telegraph departments of all armies. It is gratifying to see that this branch of English literature, which has been up to the present so poorly represented, will now be enriched by such a valuable work.

The Future of Electricity.—The following is an extract from a pamphlet recently published in Paris on the application of electricity to agriculture, by Mr. J. A. Barral, Secretary of the National Agricultural Society of France:—

> There will be applications of electricity as of steam. Thirty years ago, returning from England, where I had witnessed the first employment of steam on the farm, I said that this was the beginning of a reform in agriculture. I met only with incredulity, sneers, and expressions of pity for my impracticable views. To-day, as you all know, steam is everywhere, even in the meanest hamlets; it traverses our country roads to the great benefit of every farmer; the traction engines, constructed for use in agriculture, are utilised for other industries, and their use is becoming more extended from day to day. I expect that within thirty years a no less marvellous revolution will have been effected by electricity.

The Electrical Resistance of Carbon under Pressure.—Mr. Herbert Tomlinson, in a letter to our excellent contemporary, *Nature*, on the above subject, writes thus:—

> From the abstract of the proceedings of the Physical Society, given in *Nature*, vol. xxv., p. 426, I learn that Prof. S. Thompson has been making some experiments which tend to show that the observed diminution of the resistance of carbon under pressure in such instruments as the carbon relay, rheostat, and microphone-transmitter, is really due to the contact between the electrodes and the carbon. No doubt the greater portion of the observed diminution of resistance is due to this cause, and I have already pointed out in my paper on "The Influence of Stress and Strain on the Action of Physical Forces," Part ii., Electrical Conductivity, an abstract of which (*Nature*, vol. xxv., p. 401) was read before the Royal Society on January 26, that the effect of a given amount of longitudinal traction or compression per unit area on the electrical resistance of some carbon rods was not greater than is the case with the metals tin and lead, for whereas a stress of 1 gramme per sq. cm. produced a variation of conductivity of from 7684×10^{-12} to 11420×10^{-12} per unit in the case of five carbon rods, the corresponding numbers were, with tin and lead, 10540×10^{-12} and 173×10^{-12} respectively. The carbon rods were of the sort used for the purposes of electric lighting, and their elasticity varied in almost the same proportion as their susceptibility to change of resistance from stress, so that, the alteration of resistance divided by the strain produced, ranged in the five specimens between the limits 2·144 and 2·835. The corresponding numbers in the case of most pure metals (aluminium is an exception) are *greater* than these, and in the case of nickel, with which metal curiously enough the effect of moderate longitudinal traction is to *decrease* the resistance, the alteration of conductivity is *much* greater.
>
> It will be observed from the numbers given above that the diminution of resistance which can be produced in carbon by pressure is very slight, so much so indeed, that if we could compress a carbon rod to *half* its original length, the resistance would not be diminished to one-third of the original resistance, and that therefore the amount of compression which can be really produced without danger of breakage causes such a slight decrease of resistance as requires special precautions and a good galvanometer if this decrease is to be measured with any accuracy.

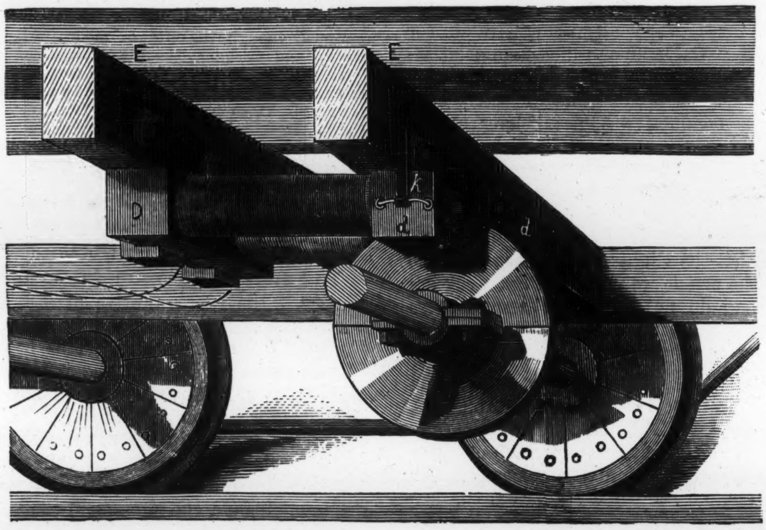
The Edison Electric Light in Milan.—Mr. James Shepherd, the representative of Mr. Edison in Milan, has very successfully applied the incandescence system to the Foyer of La Scala Theatre. This has been done by order of the municipality, and the number of lamps employed amounts to 92. Mr. Shepherd is now preparing plans and estimates for its complete adoption in this theatre, which is one of the largest in the world. A contract has also been made to light the celebrated coffee-house "Biffi," in the Victor Emmanuel Gallery, Milan. We are informed that the municipality, the press, and the general public are very much impressed with the new light, and that unqualified satisfaction is expressed on all sides.

The "New" Accumulator.—We understand that every effort is being made to work the incandescent lamps in the Alhambra Court of the Crystal Palace, within the next few days, from a battery of the new secondary cells of which we have heard so much recently.

The Salaries of Post-office Officials.—The *Citizen* states that Mr. Fawcett, the Postmaster-General, is in treaty with the Treasury with a view to increasing the salaries of Post-office officials. The contemplated increases will necessitate the extra annual expenditure of £100,000.

Comparison of Batteries and Dynamo-Electric Machines.—Some few months since Mr. F. C. Webb, in an article published by the *Engineer*, stated what an enormous number of Daniell cells would be necessary to produce the same current strength as that obtained from a 16-light Brush machine. M. Marcel Deprez has recently written to *La Lumière Electrique* on the above subject, and commences his paper by giving instances of the vague ideas the majority of those using dynamo machines possess as to the relative values of such machines when compared with batteries. He shows in a simple manner how any person can easily calculate for himself the number of cells necessary to produce such a current as that from any given machine. He compares the "A" Gramme machine of the workshop type with Bunsen cells on the Ruhmkorff model, and proves that to produce a current equal to that of such a machine running at 1,225 revolutions per minute (its internal resistance being ·36 of an ohm), with an external resistance of 1·31 ohms, and giving an electromotive force and intensity of current of respectively 65·5 volts and 39·2 ampères, it would necessitate the employment of 216 Bunsen cells, arranged in six parallel rows of 36 elements in each. He concludes by mentioning that of course for different speeds of the machine the current will differ, and that the number of elements will vary correspondingly.

ELECTRO-MAGNETIC BRAKE.—We give an engraving of Mr. Edison's recently patented electro-magnetic brake. It is designed for use on any style of railroad vehicle, but is more especially intended for use in connection with a system of electro-magnet railways. The invention consists in placing an electro-magnet in such relation to some rotating metallic portion of the running gear of the vehicle to be stopped that the magnetic circuit shall be through the rotating metallic portion, the electro-magnet being furnished with movable heads, which may move toward and clasp the rotating portion whenever the circuit of the magnet is closed. Upon the axle, and at or near its centre, is rigidly fixed a disc of iron, which rotates with the axle and between the polar extremities of an electro-magnet supported from the bottom of the car. The cores of this electro-magnet are extended beyond the coils, forming a spindle, which is reduced in size when necessary, the ends being screw-threaded to receive nuts. Upon each spindle is placed a block of iron forming a polar extension, secured in place by the nut. The orifices in the blocks, into which the spindles pass, are elongated, so that the blocks or polar extensions may have a movement to or from the fixed disc upon the axle rotating between them. The polar extensions are normally held away from the disc by suitable springs of low resilience. When it is desired to use the brake a circuit from any suitable source of electricity is closed through the coils of the electro-magnets, when the polar extensions mutually attract the disc, and the attractive force causes them to move to the disc and grasp it between them, causing a retardation or stoppage in its rotation, and so acting as an effective brake upon the wheels.—*Scientific American.*



THE ELECTRIC LIGHT IN CHURCHES.—Edison's electric light was applied to the City Temple on Sunday evening last, 170 incandescent lamps giving, it is stated (*Daily Telegraph*), an illuminating power almost equivalent to that of the 700 gas-burners hitherto in use. If this is so, either the gas-burners must have been very bad, or the Edison lamps must have been worked up to nearly three times their ordinary illuminating power of 16 candles. Taking each gas-burner as giving a light of only 10 candles, it would be necessary that each Edison lamp should possess 42 candle-power to equal the total illumination given by the 700 gas jets.

THE CRYSTAL PALACE ELECTRICAL EXHIBITION.—On Monday evening last Mr. Gladstone and other members of the Cabinet, attended by a large and distinguished party, including ladies, paid a visit to the Crystal Palace, where he was received by the chairman, manager, and some of the directors. The various systems of electric lighting were examined with evident interest.

THE GÉRARD ELECTRIC LIGHT.—We are informed that the Gérard Electric Light patents for France have been purchased by the Societé Anonyme d'Electricité for the sum of 500,000 francs.

THE COST OF LIGHTING STREETS BY ELECTRICITY.—In a note on this question the *Engineering and Mining Journal* states :—"The representative of an electric light company appeared before the aldermen of Boston recently, and said that, the present cost of lighting the streets of that city by gas being 9 cents per lamp, his company would furnish electric light at a cost of 58 cents a lamp a night ; or if the company could secure the use of the lamp-posts and lamps now owned by the city, it would furnish arc lights of 24 candle-power each, being 50 per cent more light than gas, at 13 cents a lamp a night, or light of 40 candle-power at 16 cents a lamp a night."

GAS FOR LIGHTHOUSES—ILLUSTRATED BY AN EXHIBITION OF SOME OF THE GAS FLAMES AND APPARATUS USED IN LIGHTHOUSES.—In lecturing before the members of the Society of Arts on the above subject, Mr. John R. Wigham speaks thus of the electric light in its application to lighthouses :—

"The dimensions of the usual lanterns and dioptric apparatus of lighthouses not permitting us to use gas lights of a larger size than that which I have just described, it seemed desirable to consider whether we could not usefully add still greater intensity to our lighthouse gas flames than that obtainable from gas only. All our intense lights, such as the lime light, the electric light, magnesium light, &c., are costly ; but it occurred to me that if I could add some such intense light to my large gas-burners, so arranged that it need not be used except in thick weather, I would, at comparatively small expense, produce a fog-light combining both quantity and great intensity. I made many experiments, and at length arranged for what I termed a core for my gas-burners. Any of the intense lights I have mentioned might form this core. I first used, as the simplest and least expensive, a rich hydro-carbon flame intensified by oxygen, such as I may, in passing, show you in this lightship lamp, that you may see its effect in increasing the intensity of the flame. I tried the electric light also for this purpose, because of its great intensity, and because of the facility with which, owing to the recent improvements in dynamo-electric machines, it can be applied. The light from carbon points regulated by a Serrin or Siemens lamp is quite available for the purpose. By a simple alteration in the arms which hold the carbons, and of the clockwork by which those arms are moved, we can bring the light into the precise focus of the gas-burner, and apply it at pleasure. By means of a gas-engine, which of course can be used at all gas stations, this can be done in a moment. I have read small print at Salthill by the light transmitted from these combined lights at Howth Bailey Lighthouse, almost six miles distant, a test of the power of a lighthouse light more severe than has ever before been applied, so far as I am aware. But powerful as this combination is, my experience of the behaviour of the electric light in foggy weather is such as to prevent my proceeding further with experiments in that direction. At the last meeting of the British Association I had the opportunity of laying the result of my observations before that scientific body. Briefly summed up, it is this—that while the electric light is much more intense than gas light, there is a double objection to its use at lighthouses. Firstly. That in clear weather it is misleading to the sailor, he cannot be certain of his distance from it. In some states of the atmosphere it looks equally bright whether it be ten miles off or only one. And secondly, in foggy weather, when a light is specially needed, it is more easily totally obscured by fog than the large gas lights, combining quantity with intensity, which are now used for lighthouses, and which have again and again been seen in fogs in which the electric light has been quite invisible. The opinion of many scientific men has been adduced to this effect, and the evidence is so strong, that it seems to me that the conclusion is inevitable that the electric light is not well adapted for lighthouses. Would it not be wise, in the interests of the maritime public, that this question should be thoroughly investigated, with the view of ascertaining whether it is right that this light should be used any longer at lighthouses."

THE WESTERN UNION TELEGRAPH COMPANY.—As a matter of interest to the electrical world, the Western Union Telegraph Company, two years ago the strongest known corporation in the United States, has succumbed to its rival, the American Union, and is now owned by that company, although still known by its former name.

THE CABLE-SHIP "SILVERTOWN."—The India-rubber and Gutta-percha Company's ss. *Silvertown* arrived safely at St. Vincent on the 16th instant, and left the same day for the West Coast of Central America.

THE P. O. CABLES.—The ss. *Morna*, which had been chartered by the Post-office, has returned to the River Thames, having completed a large number of repairs to cables belonging to this department.

THE PILSEN ARC LAMP.—One of these lamps is now being exhibited at Charing Cross, outside the show-room of the Faure Accumulator Company. The number of secondary cells employed for the purpose is twenty-five, and the current strength developed about eight ampères. The steadiness of this lamp under almost any circumstances (the ludicrous exhibition of it at the Society of Telegraph Engineers notwithstanding) is one of its leading features, and when worked from this secondary battery it is difficult to imagine any arc lamp more perfect.

NEW COMPANIES.—EDISON'S ELECTRIC LIGHT COMPANY, LIMITED.—Capital £1,000,000, divided into 50,000 A, or £5 per cent. preference shares, and 50,000 B shares of £10 each. Objects: To acquire the whole of the letters patents for the United Kingdom taken out by Thomas Alva Edison in relation to electricity or magnetism as a lighting, heating, or motive agent, together with the electric lamps, dynamo and other plant of Mr. Edison now in England, and capable of being used in exhibiting the patents, or in the production of electric light; and also to acquire the lease of No. 57, Holborn Viaduct. The purchase consideration is a sum in cash not exceeding £30,000, and the allotment of one fully paid B share for each £10 of capital paid up, or credited as paid up, in respect of the A shares. Signatories (with 500 shares each): *Right Hon. E. Pleydell Bouverie, 44, Wilton Crescent; *Sir John Lubbock, Bart., M.P., High Elms, Down, Kent; Howard Gilliat, 4, Crosby Square, E.C.; W. G. Rathbone, 2, Fenchurch Avenue; W. Fowler, M.P, 38, Grosvenor Square; F. J. Bramwell, 37, Great George Street, S.W.; E. Hibbert Johnson, 57, Holborn Viaduct. Directing qualification: 500 shares. Remuneration: £500 per annum to the chairman, and £200 per annum in respect of each director. Viscount Anson, Shelford Bidwell, and Richard Blaney Wade, are also directors. Registered office, 57, Holborn Viaduct. Registered 15th inst. by Waterhouse and Winterbotham, 1, New Court, Lincoln's Inn.

ELECTRICAL POWER STORAGE COMPANY, LIMITED.—Capital £800,000, in £10 shares. Objects: To carry out an agreement of the 16th inst. between John Scudamore Sellon of the first part, Ernest Volckmar of the second part, and Holland Dell (for the company) of the third part, and to carry on the business of electricians and electrical, mechanical, and chemical engineers, and of workers and dealers in electromotive power and light. Signatories (with one share each): *Sir Daniel Cooper, Bart., 6, De Vere Crescent; *Col. F. G. Stuart, 14, St. James's Square; *J. Irving Courtenay, 1, Essex Court, Temple; *W. Ladd, 11, Beak Street; *Charles Dorman, Sydenham; *W. M. Bullivant, 72, Mark Lane; *F. Green, 13, Fenchurch Street. Directing qualification: 50 shares. Remuneration: A sum not exceeding £1,500 per annum. Registered office, 74, Hatton Garden. Registered 21st inst. by Renshaws, 2, Suffolk Lane, Cannon Street.

* Signatories whose names are preceded by an asterisk are also directors.

SPARKING AT COMMUTATORS.—We notice in the last issue of our contemporary, *The Engineer*, a letter bearing on this subject, which we consider of sufficient importance to reprint, and to offer a few remarks upon. It reads as follows:—

> SIR,—It is impossible to examine the various dynamo-electric machines at the Crystal Palace without perceiving that some of these machines produce an abundance of sparks at the commutators, while others are quite free from them. The great Brush machine used on the 150,000-candle lamp keeps its commutators in a sheet of flame.
>
> Now, sparking is a great source of waste of power, and it would be interesting to know why sparking is not always prevented from taking place, and what are the causes inducing it. It is well known that it leads to the speedy destruction of the commutators, and constitutes one of the worst defects a dynamo can have. The original Siemens' machines, first used for lighthouse work, failed for this reason.
>
> FELIX.
>
> Sydenham, *March* 14*th*.

The observations of "Felix" are quite correct on the disadvantages occasioned by such sparking at the commutator, and it may interest all those either directly or indirectly connected with the working of dynamo-electric machines to know that a recently published patent specification, No. 3231 (1881), communicated by Mr. T. A. Edison, has for its object the reduction of these sparks at the commutators of machines to a minimum. We have not the space to describe here the manner in which he accomplishes his object, but the spark is divided up, and the total spark greatly reduced. The inventor says he has discovered that the spark at each point is reduced about as the square of the number of points at which the circuit is broken.

THE CADIZ AND CANARY ISLANDS CABLE.—The *Gaceta de Madrid* of March 15th gives the different clauses and conditions for the laying and working of submarine telegraph cables, in three sections, connecting (1) Cadiz with the Bay of Anteguera, Island of Tenerife; (2) Tenerife with the Island of Gran Canaria; (3) Tenerife with the Island of La Palma. The tender is to be based on a Government subvention of so much per cent. for ten years on the value of the cable. This value is taken at 5,000 pesetas, say, £200 per nautical mile. A deposit of 80,000 pesetas, or £3,200, is to be made by the concessionnaire. The other conditions are those usually found in such contracts.

THE NAPOLEON OF OCEAN TELEGRAPHY.—In the *Penny Illustrated Paper* of last week we notice an excellent portrait (not in very good company by the way) of Mr. John Pender, M.P., who is therein called the Napoleon of ocean telegraphy. We suppose the occasion of the visit of Mr. Gladstone to the Crystal Palace, at Mr. Pender's private invitation, has something to do with the illustration in question. Telegraphy is to be congratulated in having the gentleman, whose likeness we refer to, as its Napoleon. There is no mention of any Wellington of ocean telegraphy, but we have no doubt the Eastern Telegraph Company could supply this want in the person of Sir James Anderson were it necessary. The Crystal Palace electric lighting and telephonic exhibition is, we are afraid, only a means for the self-glorification of a number of gentlemen who fancy the telegraphic world moves round them. As the exhibition is only a private venture, and for the purpose of making money, it is to be hoped that Mr. Gladstone will not "ennoble" any of the gentlemen connected with it, however much the honours may be coveted.

The Telegraph Construction and Maintenance Company.—We are glad to announce the repair of the German Union Cable by the Telegraph Construction and Maintenance Company. As we have formerly pointed out, this has been a very tedious operation, and considering that about five months have been employed in re-establishing communication, in a depth of 24 fathoms, the Telegraph Construction and Maintenance Company cannot be congratulated on their success, similar work in the same locality having been carried out by Mr. Bordeaux, in the *Lady Carmichael*, in three days. Public attention has often been drawn to the so-called success of this contracting company in all the work they have undertaken. As an instance of how they deal with certain matters, we may refer to a break that occurred close to Mozambique, in the Eastern and South African Company's cables, very shortly after the cable was laid. The chairman of the Telegraph Construction and Maintenance Company, Sir Daniel Gooch, said to his shareholders what practically means this, that the cable they had laid a couple of months previous to the meeting, "had been laid on a very bad bit of ground." He continued by recommending the Cape Cable Company "to see if they could find a better piece of ground." This would appear to us a very easy way of avoiding the results of their own want of foresight, in not carrying out the work properly as it should have been in the first instance. The approaching meeting of the German Union Telegraph Company, on the 31st instant, will probably show the proper appreciation of the management in the repairs to the Lowestoft-Borkum cable, unless the meeting is thoroughly controlled by the gentlemen who are said to govern submarine telegraphs.

Defeat of Jay-Gould!!!—It is said that Mr. Pender and those associated with him have been successful in forcing Mr. Jay-Gould to accept 11 per cent. of the Anglo-American traffic for the cable just completed, and another 11 per cent. as soon as the second cable is finished. From American papers we notice that the two Jay-Gould cables cost the American Cable Construction Company about £1,200,000. Estimating the transatlantic traffic with the two shilling rate at £2,600 per day, this will be a remunerative rate to Jay-Gould, and in our opinion the forcing has been all the other way. Our heading should therefore be "Defeat of the Cable Ring."

NEW PATENTS—1882.

1222. "An improved method of, and apparatus for, transmitting and receiving telegraphic messages or signals." H. H. Lake. (Communicated by A. L. Parcelle.) Dated March 14.

1225. "Apparatus for gauging carbon filaments, wire, or other articles." M. Evans. Dated March 14.

1249. "Improvements in armatures for magneto-electric machines, and in apparatus for developing electric light." C. L. Levey and E. Lumley. Dated March 15.

1254. "An improved telegraph relay." J. Ebel. Dated March 15.

1271. "Telephones." A. W. Rose. Dated March 16.

1274. "Incandescent electric lamps." F. Wright and M. W. W. Mackie. Dated March 16.

1288. "Improvements in incandescent lamps and in fittings and switches for electric light apparatus." J. B. Rogers. Dated March 16.

1302. "An improved electrolier." Hon. R. Brougham. Dated March 17.

1303. "Telegraphic and telephonic systems and apparatus therefor." P. M. Justice. (Communicated by F. van Rysselberghe.) Dated March 17.

1324. "Electric lamps." J. D. F. Andrews. Dated March 18.

1327. "Improvements in means or apparatus to be used in connection with the transmission of electric currents of high tension." L. J. Crossley, J. F. Harrison, and W. Emmott. Dated March 18.

1328. "Improvements in electric signalling apparatus, applicable also to other purposes." L. J. Crossley, J. F. Harrison, and W. Emmott. Dated March 18.

1336. "Improvements in the manufacture of covered or insulated wire, and in apparatus or machinery therefor." A. J. Boult. (Communicated by J. D. Thomas and L. F. Requa.) Dated March 18.

1345. "Joining together or coupling lengths of telegraph wire, signalling wire, &c." D. Bremner. Dated March 20.

1347. "An improved machine for generating electric currents, applicable also as an electro-motor." S. E. Phillips. (Partly communicated by W. C Johnson.) Dated March 20.

1356. "Telephones." R. and M. Theiler. Dated March 21.

1363. "Secondary batteries." F. Maxwell-Lyte. Dated March 21.

1366. "An improved method of, and means for, working telephonic and telegraphic apparatus." A. E. Dolbear. Dated March 21.

1367. An improved method of, and means for, providing ground or earth connections for electrical circuits." A. E. Dolbear. Dated March 21.

1368. "Electrical cables." A. E. Dolbear. Dated March 21.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

3140. "Fac-simile telegraphs." E. G. Brewer. (A communication from abroad by Thomas Alva Edison and Patrick Kenny). Dated July 19. 8d. In carrying out this invention use is made of the depressions produced upon the surface of paper by marking, writing, or sketching thereon with a hard lead pencil or other suitable instrument.

3166. "Electric lamps." W. M. Brown. (A communication from abroad by Gustavus Palmer Harding, of Paris.) Dated July 20. 6d. Relates to the kind of lamps known as gravity and regulator lamps. In one form, fig. 1, the carbon is suspended by any ordinary means, such as a chain, cord, or metallic band, A, or other suitable means, and is regulated to descend as required by means of an escapement, B, which is actuated by an automatic make and break (shunt) or other equivalent device, C, such escapement being arranged with a recoil action, and so that the recoil is equal to one half, one quarter, or any desired amount of the feed, which recoil serves to produce the arc by giving falls of precise measure, and separation of the carbons after contact. In this kind of lamp the inventor prefers to use the telescopic carbon holder, D, made by taking two or more tubes, E, E^1, which are made to slide in each other. To the top end of the smallest tube, E^1, is fixed a chain, cord, or metallic band, A, and to the bottom end is fixed the carbon rod, F. By the use of this form of holder the length of the lamp is considerably reduced; or a socket for holding the carbon may be used, sliding between guide rods or grooves, in which case, the carbon holder being short, the length of carbon may be increased or that of the lamp decreased. Fig. 1A is a diagram representing this form of lamp. A, A^1, is a metallic chain or cord which is wound on a pulley, C, the escapement shown in fig. 1 being placed near. The pulley, C, is fixed on the same spindle as the escapement. The action of the current on entering the lamp is to pass through, shunt, coil, and attract the armature, which, moving the escapement, allows one tooth of wheel to escape and carbon to fall; contact is then made by platinum point, and armature freed, when escapement moves back and recoil is obtained; this takes place until carbons are in contact, and on separation by recoil the lamp is lighted. Fig. 2 represents a new form of clutch lamp. In this lamp a "cone" "clutch" is used, which is made of a tube of brass, A, the end of which is made in the shape of a double cone, and is split vertically up a certain length into two or more parts; on the top of this cone clutch is fixed the armature, B, which is actuated by a pair of electro-magnets or solenoids, C, C^1; on the opposite side of the armature are two adjustable springs, D, D^1, which act in opposition to the magnets. The inner cone or clutch works in another split tube or cone, E, which is fixed to the base of the lamp. It is evident that when the cone clutch moves down, being split, it will spring open, and thereby release the carbon holder, F, and in ascending it will grip and raise the carbon holder, thereby forming an arc.

FIG. I.

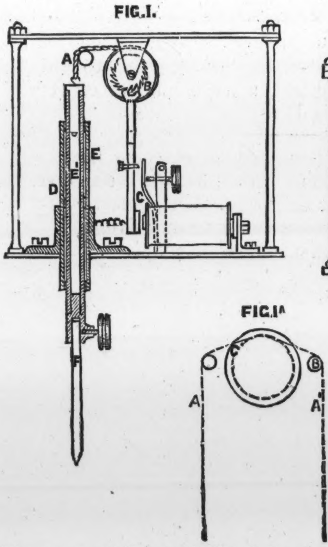


FIG. 2

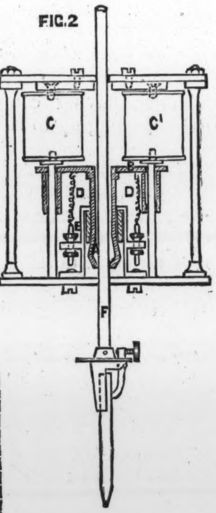


FIG. IA

3187. "Electric lamps," &c. W. R. LAKE. (A communication from abroad by Joseph V. Nichols, of New York.) Dated July 21. 6d. Relates to electric lighting apparatus of that class known as incandescent lamps, and comprises improvements in the manner of forming the inclosing globe, sealing the metallic conductors into the same, and attaching the carbons to the end of the wires. As usually constructed the inclosing globe or receiver containing the incandescent carbon conductors has a projecting neck or a solid mass of glass containing the conducting wires and sealed into an opening in the globe. The shape of the lamps is thus rendered very uneven, the lamps themselves are expensive and very liable to be broken. It is the object of the present invention to do away with these necks entirely, and for this purpose the wires are first embedded in a small circular disc of a vitreous cement, or, in other words, a composition of potash, silica, and oxide of iron and copper. This disc is sealed directly into the opening of the main globe by the aid of a blow-pipe, and the exterior surfaces of the two made smooth and even, so that no projections are left which are liable to be broken in handling or in transportation, while a perfect union and air-tight joint is secured between the glass and the conducting wires, even when the latter are of copper.

3189. "Electric lamps, &c." W. R. LAKE. (A communication from abroad by Hiram Stevens Maxim, of New York.) Dated July 21. 8d. Relates to incandescent lamps and to the method of manufacturing the same, involving improvements in the means for sealing the wires into the globe surrounding the light-giving or incandescent conductor, novel and useful processes for the treatment and preparation of the carbon conducting strips or filaments and certain accessory devices for use with the said lamps when completed.

FIG.I.

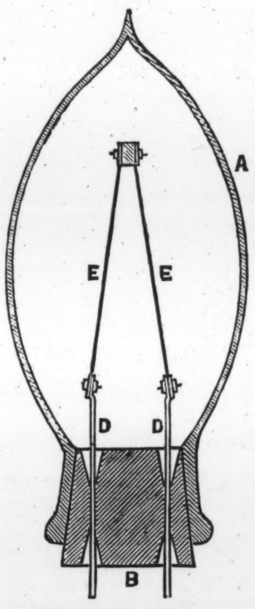


FIG.2.

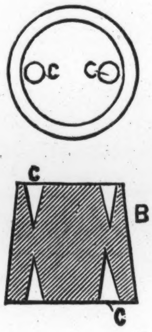


FIG.3

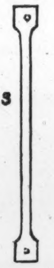


Fig. 1 shows a vertical section, and fig. 2 a plan and vertical section, of a lamp constructed according to the invention. A is a globe having an open neck, into which is shown fitted the stopper, B, containing the conducting wires, D, D, which are embedded therein, and support the conductors, E, E, one of which is shown in side view in fig. 3. In fig. 2 is represented the stopper as it comes from the mould, and before the oppositely disposed conical indentations, C, C, are united by the drilling process. A lamp thus made is both durable and cheap, and may be constructed by any ordinarily skilled workman. The exhaustion of the confined air is effected as in the other forms, and much that involves the art of glass blowing is dispensed with in its manufacture.

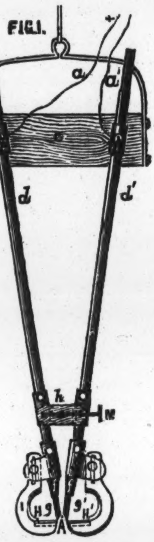
3190. "Fittings for electric lamps, &c." RICHARD HUGH HUGHES. Dated July 21. 6d. Has for its object improvements in fittings for electric lamps, which improvements are applicable to rendering gas fittings suitable for electric lighting.

3238. "Electric contact for electric clocks, &c." B. J. B. MILLS. (A communication from abroad by Georges Leclanché, of Paris.) Dated July 25. 6d. Consists in making contacts by means of a globule of mercury in a glass tube, the latter being tilted up when required, so as to cause the globule to run to the end of the tube over the points of two wires, and thus complete the circuit.

3247. "Self-acting electric clocks." F. T. REID and J. U. VALENTINE. Dated July 25. 6d. According to this invention there is a wheel of ivory with four platinum contact points, each being in communication with a brass central axis common to all, the electric circuit being completed by a contact spring. The ivory wheel is provided with four large ratchet-shaped teeth, which, revolving once in four minutes, lift the contact spring, which when free from the tooth falls upon the platinum point adjacent thereto on the ivory wheel, and thus completing the circuit. The electro-magnet then attracts its armature and sets going a relay battery for working the dials; this action of the armature throws back a detent, and thus allowing an ivory hammer to fall on the contact spring, and in this way to throw the platinum plate into the further ratchet tooth, thus freeing itself from all the contacts during a period of one minute, the ivory hammer being previously lifted into its detent by four pins fixed laterally on the ivory wheel. When contact is made by the contact spring the electric current also passes around another electro-magnet, attracting another armature, and so winding the clock by a ratchet arrangement. Very little battery power is required, two or three cells being under ordinary circumstances sufficient: two extra cells would work twelve dials. The spring is always pulling at one strength, consequently the time must be accurate.

3214. "Electric lamps." A. M. CLARK. (A communication from abroad by Léonard Jules Bouteilloux and William Laing, of Paris.) Dated July 22. 8d. Relates to electric lamps or regulators wherein the regulation of the carbons is effected automatically by the action of gravity. In fig. 1 the apparatus consists mainly of two tubular carbon holders of metal, *d*, d^1, open throughout, and which may if necessary be provided at the lower ends with tubular extensions of insulating material. The tubes are of such diameter that the carbons, *g*, g^1, may slide freely through them from one end to the other when placed in a vertical or inclined position. The carbons rest at their lower ends upon supports, I, I^1. The carbons are inclined towards one another, and the distance between their lower ends is adjusted by means of a screw, M, proportionately to the power of the current produced by the generator. This done, and the lamp having been put in communication with the generator, the incandescent molecules are replaced as fast as they are consumed by those above, the carbons being fed downwards in a gradual and continuous manner by their own gravity without jerks, and without the aid of any mechanism or any intervening non-conducting material. They will also, especially if of good quality, burn with great regularity without changing their relative positions, and without any variation of the distance apart at which they were originally set. Upon the lower part of the carbon holders, *d*, d^1, are placed sockets, J, J^1, capable of sliding thereon, and held in place by binding screws. These sockets carry the supporting arms, I, I^1, made of any suitable conducting or nonconducting material, and pivoted thereto at *z*, to permit of their adjustment. These supports are provided with recesses to receive blocks, H, H^1, of some refractory material, such as lime, magnesia, &c., upon which the lower ends of the carbons directly rest.

FIG.I.



3254. "Cables or conductors for telegraphic purposes, &c." H. H. LAKE. (A communication from abroad by David Brooks, junior, of Philadelphia, United States of America.) Dated July 26. 6d. According to this invention there are provided uninsulated metallic wrapped wires and an inclosing metallic pipe, the wrappings being in contact with each other and with the inclosing pipe forming an electrical communication between all of the metallic wrappings inside of the pipe and the pipe itself, whereby the induced currents are carried off to the exterior pipe, and the inductive effects upon the other wires are prevented or lessened.

3274. "Lamp casings or holders for containing and protecting electric lights, &c." DAVID GRAHAM. Dated July 26. 10d. This invention relates chiefly to an improved casing or lanthorn for containing and protecting electric lights, either the incandescent, partly incandescent, or arc lights. The lanthorn or casing when constructed for incandescent lights consists of an upper part, into which the conductors from a battery or an electro-dynamic machine are led. This upper part is hollow in the inside, and so arranged as to receive the stem and contact pieces of a "Swan" or equivalent electric lamp. This upper part is connected by one or more bayonet or equivalent joints to the lower part or lanthorn proper, and the two parts are locked together by means of a padlock, which consists of an upper and lower metallic portion connected together by wires or bars of metal bent or shaped according to the contour of the glass portion of the lanthorn, this glass portion being preferably cushioned elastically within the metallic portion, and adjusted together with the protecting wires or bars by a nut and screw or equivalent arrangement at the lower part. The upper and lower parts of the lamp casing or lanthorn are provided with swivel rings for suspending or carrying the same.

3294. "Electrical musical instrument." W. F. SCHMOELE and ALEXIS MOLS. Dated July 27. 8d. Relates to an instrument which may be played by means of a keyboard of its own, or which may be applied to a piano, and be caused to play upon the same automatically. In the former case it acts as a reed instrument alone, in the latter case the music of the piano may be produced alone or be combined at pleasure with that of the reed notes.

3327. "Electric apparatus for automatically giving alarms." J. L. RASTRICK. Dated July 30. 2d. Consists in utilising the expanding or contracting properties of metals, fluids, air, and gases, also the buoyancy and contracting action of fluids in connection with an electric battery to give notice by an alarum when there is an excess of or reduction of pressure, high or reduced temperature, or an excess of fluid in mines, ships' holds, boilers, buildings, or where an alarum is necessary.—(*Provisional only.*)

3380. "Apparatus for detecting and recording the passage or stoppage of an electric current through a conductor." W. P. THOMPSON. (A communication from abroad from Jacques Adrien Pel, of Belgium.) Dated August 4. 6d. Consists generally of an electro-magnet in circuit with the line wire, the armature of which when moved causes a mark to be made on a paper dial.

3404. "Apparatus or appliances for automatically lighting electric candles." E. G. BREWER. (A communication from abroad by Auguste Guilbert Desquiens, of Paris.) Dated August 5. 2d. The apparatus is composed of a platform which may be of onyx, marble, or other transparent material, on which a series of candle burner supports, positive and negative, is mounted. The electric candle is firmly held between two of these supports, one for the positive, and the other for the negative. Each positive support is constructed as follows:—This support, which is the principal object of the invention, carries on its external face a lever provided with a hollow axle, in the interior of which there is a spiral spring mounted on an axis riveted to a plate screwed on the support which carries a conducting arm, which serves to put each of the supports in communication the one with the other by means of the levers which come in contact with the arms when an electric candle is consumed. —(*Provisional only.*)

3409. "Regulating the dynamical production of electricity." G. WESTINGHOUSE. Dated August 6. 6d. Relates to means of automatically regulating the production of electricity dynamically by employing the electricity itself as a governor in the following manner:—In the main circuit of the electric current, or in a by-pass circuit, is introduced a solenoid coil having an iron core free to move within it, and urged in one direction by a weight or spring. To this core is attached a balanced valve, which governs admission and emission ports of a cylinder. The piston of the cylinder is connected to the regulating valve of the engine, which drives the dynamo-electric machine, and the cylinder is furnished with a supply of steam, or water, or other fluid under pressure. According as the electricity passing through the coil of the solenoid varies, the core is caused to move, and the valve being thus shifted, the piston is subjected to pressure on the one side or the other. The piston moving in obedience to the pressure alters the regulating valve of the main engine, and thus causes it to move, and to drive the dynamo-electric machine with greater or less rapidity, as the case may be. The regulating piston may be subjected to the fluid pressure only on one side, being urged in the opposite direction by an adjustable spring. Instead of connecting the piston to the regulating valve of the engine, it may be connected to one or more of the field magnets of the dynamo-electric machine, these magnets being fitted to slide to or from the revolving coils. According as the regulating piston is urged in the one direction or the other, the field magnets connected to it are advanced towards or withdrawn from the revolving coils, thus inducing currents more or less powerfully, as the case may be.

3412. "Fluid for galvanic batteries." THEOPHILUS COAD. Dated August 6. 2d. The fluid is manufactured as follows:—To a hot saturated solution of nitric acid, bichromate of potash, and nitrate of potash, is added about one fourth part by measure of sulphuric acid. The solution is allowed to cool, and is then fit for use.

3435. "Incandescent electric lamps." FRANK WRIGHT. Dated August 8. 2d. Consists in means of securing to the conductors of an incandescent electric lamp the ends of the wire, fibre, or filament which constitutes the bridge that is rendered incandescent by the passage of electricity through it.—(*Provisional only.*)

3437. "Incandescent electric lamps." FRANK WRIGHT. Dated August 8. 2d. Relates to the preparation of fibres or filaments suitable for forming the incandescent bridge of an electric lamp, and to the construction of stoppers for such lamps, with appliances for exhaustion of the lamp and conduction to the fibre or filament.—(*Provisional only.*)

3455. "Electric lighting." W. E. HUBBLE. (A communication from abroad by A. F. W. Partz, of Philadelphia, United States of America.) Dated Aug. 9. 2d. The object of this invention is to light public places, streets, and avenues by reflected light derived from powerful luminous sources, which are hidden from view and easily accessible.—(*Provisional only.*)

3456. "Electrical apparatus for lighting, &c." W. R. LAKE. (A communication from abroad by Albert L. Arey, of America.) Dated Aug. 9. 2d. Relates to improved electrical apparatus for lighting and other purposes, and consists in various novel features.—(*Provisional only.*)

DISCLAIMER.

1881. 1412. "Manufacture of carbons for incandescent electric lamps." Graham's disclaimer and memorandum of alteration. (Scott and Akester's patent.) Filed February 3, 1882.

CITY NOTES.

OLD BROAD STREET.

DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.—The report of the directors, to be presented at the meeting of shareholders as we go to press, states that the accounts for the half-year ending 31st December, 1881, show a balance to the credit of profit and loss of £4,910 13s. 10d. The receipts are in excess of those for any previous half-year since the formation of the company. The Bilbao Cable was interrupted on the 28th November, but was promptly repaired, communication being restored on the 15th December, and this cable has since then been in perfect working condition, while the Marseilles-Barcelona Cable has been throughout the half-year (and continues to this day) in excellent order. The cost of repairing the Bilbao Cable has, to the extent of £2,880 9s. 9d., been paid out of the revenue of the last half-year, £300 having been taken from the reserve fund, leaving a balance of £5,200 at the credit of that fund. After paying the dividend on the preference shares, amounting to £2,921 10s., there will remain a balance of £1,989 3s. 10d., out of which it is proposed to pay the same rate of dividend on the ordinary shares as for the previous half-year, viz., 3s. per share, free of income tax, absorbing £1,939 13s., and leaving a balance of £49 10s. 10d. to be carried forward. The warrants in payment of the ordinary and preference dividends will be issued as soon as remittances from Spain for the balance of the telegraph accounts to 31st December last are received. These remittances may be expected in the latter part of April. Mr. Scott and Mr. Bannatyne are the directors retiring by rotation, and, being eligible, offer themselves for re-election. Mr. James Cowan is eligible for auditor for the present year.

THE EASTERN EXTENSION AUSTRALASIA AND CHINA TELEGRAPH COMPANY (LIMITED).—The accounts of this company to the 31st December last show (subject to audit) a balance of profit of £121,196 after payment of three interim dividends and a bonus for the first half-year. Against this sum the board have charged £34,363 in part payment of the new Singapore-Batavia cable, and they now propose to pay on the 20th April next a final dividend of 2s. 6d. per share, together with a bonus of 1s. per share (both free of Income-tax) making with previous distributions a total payment of 6 per cent. for the year 1881. A balance of £51,876 is carried to the reserved fund, which now stands at £276,203.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotations. March 22	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	4	9¼- 9¾	9½.⅝.$\frac{9}{16}$
		Do. Do.	10	22½- 23½	22¼
150,000	1	Electric Light and Power Generator Co.	1	¾- 1	⅞
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	51½- 52	51½.⅞
2,441,800*l.*	Stk.	Do. Preferred } Def'd. receiving no div. until	100	81½- 82	82.1¾.½*
2,441,800*l.*	Stk.	Do. Deferred } 6 p. c. has been paid to Pref.	100	22¾- 23¼	23.22½
130,000	10	Brazilian Submarine, Limited	10	11⅛-11⅜	11¼.⅜
16,000	10	Cuba, Limited	10	8 - 8½	
6,000	10	Do. 10 per cent. Preference	10	15½- 16½	
13,000	10	Direct Spanish, Limited	9	6¼- 6¾	6⅝
6,000	10	Do. 10 per cent. Preference............	10	15¾- 16¼	
65,000	20	Direct United States Cable, Limited, 1877	20	11 - 11¼	11$\frac{3}{16}$
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	100 -103	
380,000	10	Eastern, Limited..............................	10	10 - 10¼	10⅛
70,000	10	Do. 6 per cent. Preference	10	12⅝- 12⅞	12⅝
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	100 -103	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	102 -107	
199,750	10	Eastern Extension, Australasia & China, Limited	10	11⅛- 11⅜	11¼
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891....	100	106 -110	
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	102 -105	
140,000	100	Do. do. registered, repayable 1900	100	102 -105	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300*l.*	100	{ Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan. 1900 }	100	101 -104	
345,700*l.*	100	Do. do. do. To Bearer ..	100	101 -104	102¾.3
22,050	10	German Union Telegraph and Trust, Limited	10	9¼- 9¾	
163,390	10	Globe Telegraph and Trust, Limited...............	10	6⅛- 6⅜	6$\frac{5}{16}$.$\frac{3}{16}$
163,209	10	Do. 6 per cent. Preference...............	10	12⅛- 12⅜	
125,000	10	Great Northern	10	12 - 12½	12½
100,000*l.*	100	Do. 5 per cent. Debentures	100	102 -105	
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	24½- 25½	24⅞
100,000	100	Do. 6 per cent. Debentures, 1886	100	104½-108	
17,000	25	Indo-European, Limited	25	27½- 28½	
38,148	10	London Platino-Brazilian, Limited	10	4¾- 5¼	
12,000	10	Mediterranean Extension, Limited	10	1¾- 2¼	2$\frac{1}{16}$
8,200	10	Do. 8 per cent. Preference...............	10	8¾- 9¼	
9,000	8	Reuter's, Limited	8	12¾- 13¼	
280,000	Stk.	Submarine	100	260 -270	260*
58,225	1	Do. Scrip	1	2¼- 2½	
4,200	Cert.	Submarine Cables Trust	100	100 -103	
37,350	12	Telegraph Construction and Maintenance	12	29½- 30½	30¼
150,000	100	Do. 6 per cent. Bonds, 1884 ..	100	101 -105	
186,750	5	Do. 2nd Bonus Trust Cert. ..	5	1½- 1¾	1⅝.$\frac{9}{16}$
30,000	10	West Coast of America, Limited.................	10	4¾- 5¼	5
150,000	100	Do. 8 per cent. Debentures	..	..	
69,910	20	Western and Brazilian, Limited	20	8½- 8¾	
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	105 -110	
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	98 -101	
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	124 -129	
1,030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	102 -105	103
88,321	10	West India and Panama, Limited	10	1½- 1¾	1$\frac{11}{16}$
34,563	10	Do. 6 per cent. 1st Preference	10	7½- 8	7⅞.⅝
4,669	10	Do. 6 do. 2nd do.	10	6 - 6½	
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	1¼- 1½	
200,000	1	Oriental Telephone Co.	½	⅜- ⅝	
100,000	5	United Telephone Co.	5	13 - 13½	13.

* Exceptional amount at special price.

[illegible] PATERSON,

TELEGRAPH & ELECTRICAL ENGINEER,

St. Paul's Works—76, LITTLE BRITAIN, LONDON, E.C.,

AND

European Telegraph Works—POWNALL ROAD, DALSTON.

(PARIS AGENTS—E. & S. DELEVIGNE, 8, RUE MARTEL, PARIS.)

Prize Medal, International Electrical Exhibition, Paris, 1881.

MANUFACTURER OF

Telephones, Transmitters, Switchboards,

AND ALL ACCESSORIES FOR

TELEPHONE EXCHANGES.

Electric Signals for Mines, Houses, Ships, &c. Block and Needle Instruments for Railways.

Silk and Cotton covered Wires; Rubber covered Wires for Electric Signals; Electric Light Leads.

THE DOUBLE INDUCTION MOTOR FOR SEWING MACHINES, &c.

Batteries, Insulators, and other Telegraph Stores. Continuous Copper Band Lightning Conductors.

AYRTON & PERRY'S

Instruments for Electric Light Measurements.

Ammeter.

Ohmmeter.

Voltmeter.

Electric Power Meter.

AYRTON & PERRY'S

Dynamometer Coupling.

Dispersion Photometer.

THE GOWER-BELL

LOUD SPEAKING TELEPHONE.

As adopted by
Her Majesty's Government.

ELECTRIC LIGHT LEADS, GUTTA-PERCHA, INDIA-RUBBER, COMPOUND BRAIDED COTTON, SILK COVERED WIRES.

SPECIAL WIRES FOR DYNAMO MACHINES.

PHILLIPS BROS.,

ELECTRICAL WIRE MANUFACTURERS,

MACINTOSH LANE, HOMERTON,

LONDON.

ESTABLISHED 1870.]

SPECIAL WIRES FOR INCANDESCENT LAMPS.

[illegible] WIRES, &c. &c. MULTIPLE, AERIAL, AND SUBTERRANEAN CABLE WIRES TO ANY SPECIFICATION.

INDIA-RUBBER, GUTTA-PERCHA, & TELEGRAPH WORKS COMPANY, LIMITED.

Offices and Warehouses: 106 & 100, CANNON STREET, LONDON, E.C.
Works: Silvertown, Essex; Persan-Beaumont, France.

TELEGRAPH ENGINEERS & MANUFACTURERS
OF

CABLES.—Submarine, Subterranean, and Aerial.

WIRE.—India-Rubber and Gutta-Percha covered in all gauges.

INSTRUMENTS.—"Morse" Inkers, Single Needle, Wheatstone's Alphabetical, Semaphore "Block" Instruments, Bells, Resistance Coils, Sir W. Thomson's and other Galvanometers, Condensers, Testing Instruments, &c.

BATTERIES.—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF THE CELEBRATED LECLANCHÉ BATTERY, which has received the most favourable reports from the Postal Telegraph Authorities and other eminent Telegraph Engineers, and is now in general use by the Post Office and English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

INSULATORS.—Ebonite, Porcelain, Brownware, &c.

MANUFACTURERS OF THE MOST IMPROVED APPARATUS FOR **RAILWAY BLOCK-SIGNALLING.**

SEMAPHORE REPEATERS, "LIGHT" INDICATORS, AND WALKER'S "PASSENGER AND GUARD" COMMUNICATOR.

TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

TORPEDO APPARATUS.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY (Limited) are Patentees and Manufacturers of a Complete System of Torpedoes for Harbour and Coast Defence, and of the

SILVERTOWN PATENT FIRING BATTERY.

A Constant Battery for Mining and Blasting Purposes.

CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES.

MANUFACTURERS OF

VULCANISED INDIA RUBBER.

Valves, Sheet, Buffers, Springs, Washers, Wheel Tyres, Cord, Tubing, and Door and Carriage Mats.

INDIA RUBBER AND CANVAS SUCTION AND DELIVERY HOSE.

India Rubber and Canvas Steam Packing—Round, Square, and Sheet.

INDIA RUBBER MACHINE DRIVING BANDS.

WATERPROOF GARMENTS AND FABRICS:

Coats, Capes, Leggings, Hats, Helmets, Knee Wrappers, Diving Dresses, Sheeting for Hospitals, Water and Air Proof Beds, Pillows, Cushions, Bottles, Baths, Life Belts, Gas Bags.

EBONITE.

Not affected by Vinegar or Hydrochloric or Acetic Acid.

Pumps.
Photographic Articles.

Speaking Tubes, Mouthpieces.
Battery Cells.

Sheet and Rod.
Surgical Appliances.

GUTTA-PERCHA.

Tubing, Belting, Buckets, Bosses for Flax Spinning, &c.

Works: SILVERTOWN, ESSEX, LONDON, E.; PERSAN-BEAUMONT, FRANCE.
London Office—106, CANNON STREET, E.C.
Warehouse—100, CANNON STREET, E.C.

BRANCHES:

LIVERPOOL	52, Castle Street.	BELFAST	53, High Street.
GLASGOW	20, Dixon Street.	DUBLIN	15, St. Andrew Street.
BRADFORD, YORKSHIRE	[illegible]	BRISTOL	[illegible] Street.
SHEFFIELD	10, [illegible]	NEWPORT, MON.	[illegible]
PORTSMOUTH	49, High Street.	CARDIFF ...	Pierhead Chambers, Bute Docks.

NEWCASTLE-ON-TYNE ... 21, Grainger Street West.